

DYNAMICS OF THE MAGNETOSPHERE AND ITS COUPLING TO THE IONOSPHERE ON MULTIPLE SCALES

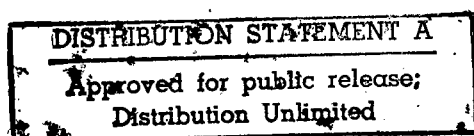
**from INTERBALL, ISTP satellites
and ground-based observations**

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Session I:

Inner Magnetosphere and Ring Current

NONLINEAR DYNAMICS OF CYCLOTRON MASERS IN THE MAGNETOSPHERE

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Recent analytical and numerical results concerning nonlinear wave-particle interactions in the magnetosphere are reported. In particular, spatial and temporal structuring of energetic particles and electromagnetic radiation due to nonlinear dynamics of cyclotron masers is considered. Formation of non-steady sharp features on the energetic particle distribution functions due to natural and artificial processes and the role of these features in generation of fine-structured electromagnetic emissions is studied. Effects of the second-order cyclotron resonance due to compensation of the phase mismatches caused by the magnetic field inhomogeneity and spatio-temporal dependence of the energetic particle distributions are investigated. Related problems for modern experimental studies are discussed.

Paper Number: Ring.01

THE GEOMETRY AND THE MAIN PROPERTIES OF TAIL AND RING CURRENTS

E.E. ANTONOVA*Skobeltsyn Institute of Nuclear Physics Moscow State University, Moscow, 119899, Russia*

Scientific tasks of INTERBALL projects includes the investigations of the structure and dynamics of high latitude current systems including tail current and high latitude parts of the ring current. Such investigations require the obtaining of the pressure distribution in the high latitude magnetosphere and the analysis of magnetic field variations. During the realization of the theoretical part of INTERBALL project it was shown that existing models of the magnetospheric magnetic field does not include high latitude quasi-ring current connected with the existence of hot plasma at geocentric distances from the equatorial projection of the inner boundary of the auroral oval till the geocentric distances of the order of 10 Re. The topology of current lines of this current system is near to the topology of cut rings near noon. Quasi-ring current system can contain eastward (real or effective) and westward currents. The introduction of such current system lead to the modifications of the conclusions on the role of the ring current in the inner magnetospheric dynamics based on the Dessler-Parker-Skopke theorem. The possibilities of the INTERBALL data base using for the verification of the theory predictions are discussed.

Paper Number: Ring.02

STORM RING CURRENT ASYMMETRY AND STORM-SUBSTORM RELATIONSHIP

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All published cases of direct space observation of a ring current asymmetry are analyzed. To the day, just one case has been registered on a time scale compared with substorm duration (~ 1 hour) [1]. As was shown, in that case the night-day asymmetry of main-phase ring current measured at high altitude has opposite sign in comparison with the ground based data. This effect has been explained as a result of distortion of Dst-variation by strong polar electrojets. Today, the concept of the "main" substorm of a magnetic storm has been developed [2]. The "main" substorm is characterized by lowest latitude position of auroral electrojets during the main phase of a storm. Various approaches to the study of an empirical dependency of the west electrojet position on Dst amplitude are compared.

- 1 V.I.Lazarev, L.V.Tverskaya, M.V.Teltsov, O.V.Khorosheva. Asymmetric injection of ring-current protons during July 6, 1974 storm. *Geomagn. and Aeron.*, 1977, v. 17, p.159.
- 2 L.V.Tverskaya. Diagnosing the magnetospheric plasma structures using relativistic electron data. *Physics and Chemistry of the Earth*, 1998 (in press).

This work was supported by the Russian Foundation for Basic Research, grant no.97-02-16870.

Paper Number: Ring.03

**LONG-TERM VARIATIONS OF THE OUTER BELT RELATIVISTIC ELECTRONS
OBSERVED WITH GLONASS AND GEOSYNCHRONOUS SATELLITES**

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I.A. RUBINSTEIN, E.N. SOSNOVETS, L.V. TVERSKAYA, AND N.A. VLASOVA

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Dynamics of the outer belt relativistic electrons ($E_e \sim 1-5$ MeV) for the period 1994-1997 years is investigated. We analyze the simultaneous data from both GLONASS (circular orbit at ~ 20000 km altitude, inclination $\sim 65^\circ$) and geosynchronous satellites. Semi-annual variations of the fluxes with two relative increases in spring and fall are observed. Some of the ISTP magnetic-cloud events are investigated as well. An effect of appearance of relativistic electrons during magnetic storm and further diffusion of electrons to lower L-shells is studied. The roles of both "usual" and "fast" diffusion due to sudden compression of the magnetosphere in the dynamics of radiation belt are also discussed.

Paper Number: Ring.04

THE SELF-CONSISTENT THEORY OF QUASISTATIONARY ENERGETIC ELECTRON AND PROTON PRECIPITATION IN THE INNER MAGNETOSPHERE

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Formation of a zone of energetic charged particles precipitation during magnetic storm is analyzed. As a mechanism of such precipitation the cyclotron instability, developing in the region with enhanced background plasma density, is considered. Such a region may be formed in the evening sector of the magnetosphere during the recovery phase of a magnetic storm due to restructuring of the plasmasphere.

The source of energetic particles is located at the nightside of the magnetosphere and they enter the interaction region due to azimuthal drift.

In the framework of self-consistent quasi-linear theory of cyclotron instability the distribution functions of energetic charged particles are found in the cases of electron and proton injection. The spatial dependencies of trapped and precipitating particle fluxes, electron and proton energetic spectrum and wave frequency spectrum are analyzed. The results obtained are compared with experimental data from NOAA satellites.

Paper Number: Ring.05

STRUCTURE OF THE OUTER REGION OF THE EARTH RING CURRENT DURING SOLAR MINIMUM

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The spatial and temporal distribution of charged particles in the Ring Current during a period of the solar activity minimum (from September 1995 to September 1996) is analyzed. The study is based on measurements made by the energetic particle spectrometer SKA-2 and plasma spectrometer Promics-3 on board the Interball Tail Probe. The emphasis is on the study of the Ring Current outer edge in the nightside magnetosphere. A strong instability in this region was found over a wide longitude range.

Paper Number: Ring.06

**GAPS OF THE PROTON FLUXES IN THE INNER MAGNETOSPHERE:
COMPARISON OF THE EXPERIMENTAL DISTRIBUTION FUNCTIONS
WITH THE MODEL CALCULATIONS OF PARTICLES DRIFT**

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Proton flux dropouts which we refer to as "gaps", are frequently observed irrespectively of longitudinal sector by INTERBALL-Auroral upon traversal of the auroral zone at altitudes of about 13,000 up to 20,000 km. The gap variety that spreads over several hundreds of a few eV up to several keV is observed in the morning and dayside magnetosphere. It is argued that such gaps are due to magnetospheric residence times well above the ion life time. This interpretation is supported by numerical orbit calculations which reveal extremely large (up to several tens of hours) time of flight in a limited energy range as a result of conflicting ExB and gradient-curvature drifts. The experimental results show a prominent dependence of the gap boundaries upon the energy and the pitch angle. On the high-energy side of the gap the proton flux exhibits a V-like shape: the minimal energy is observed near the 90° pitch angle and it is increased at the angles less and higher than 90°. As for the low-energy side of the gap, the distributions of the protons become more a square-like pattern with a noticeable flux in the anti-parallel (outgoing) direction and there exist down flowing protons. The characteristic energies obtained numerically are correspond to those measured by INTERBALL-Auroral.

Paper Number: Ring.07

MAGNETOSPHERIC STORM-TIME VARIATION

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We used 68,000 measurements from the database of Fairfield et al. [1994] for studying the response of the magnetic field at distances of $10 R_E > x > -40 R_E$ to changes in the Dst index. An enhancement of the storm time depression results mainly in increasing of the cross-tail current. The growth of the ring current is not pronounced. The database was used for direct tracing of the whole magnetic field lines under various levels of the storm activity. The storm-time variation in the field line configuration appeared to be much more significant than that predicted by other magnetic field models.

Paper Number: Ring.08

**PARTICLE POPULATIONS IN THE INNER EARTH'S MAGNETOSPHERE
AS OBSERVED BY POLAR CAMMICE MICS INSTRUMENT**

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The Magnetospheric Ion Composition Sensor (MICS) of the Charge and Mass Magnetospheric Ion Composition Experiment (CAMMICE) instrument onboard POLAR probes the composition of particle population in the Earth's magnetosphere over the range of about 10 keV/e to 200 keV/e. Periods when POLAR was near magnetic midnight (2200 - 0200 MLT) were examined to study the substorm-associated signatures in the plasma sheet. On many passes, a plasma sheet-like (10 - 50 keV) population overlapped the radiation belts at $L = 5 - 6$. These spectacular features also showed a sharp earthward boundary. As many of these structures appeared after substorms during recovery phase, we associate them with substorm-related inward injection of plasma sheet material in the mid-latitude region. The relation of these observations to earlier observations of substorm injections at low magnetic latitudes and to the injection boundary model are discussed.

Paper Number: Ring.09

**TEMPORAL AND SPATIAL EFFECTS IN NEAR-KEV ELECTRON PLASMA
AT GEOSYNCHRONOUS ORBIT**

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To analyze the data from our electrostatic spectrometers installed on GORIZONT-35 we have developed a technique of detailed description of near-keV electron plasma in geosynchronous orbit with use of multi-Maxwellian distribution function. This method is based on the fitting of measured spectra with superposed Maxwellian distribution functions. In most cases only two well-known Maxwellian populations are seen but sometimes an additional third and even fourth population appears. Some of those additional populations may be obviously associated with injections identified by A-indices. Changes of the Maxwellian temperature of such population are being traced and their possible spatial or temporal nature is discussed. Behavior of the indicator of fitting quality is examined on its relationship to geomagnetic activity indices. We also study the determined temperatures and densities versus both local time and space weather indices. Season variation of the plasma flux intensity in the night sector of the orbit is also discussed.

Paper Number: Ring.10

**COMPARISON OF ION SPECTRAL INTENSITY GAPS OBSERVED FROM INTERBALL-2
WITH THOSE DERIVED FROM SEVERAL CONVECTION MODELS****N.YU. BUZULUKOVA***Space Research Institute of RAS, Moscow, 117810, Russia*

There exist large-scale convection models based on different approaches which can be not consistent with each other. On the other hand it is usually rather difficult to analyze to what extent particular experimental data are consistent with one or another convection model in wide range of MLT and L-shells.

Interball-2 satellite measurements (ION and SKA-3 experiments) present unique possibility to test global convection models and to construct new ones using narrow sharp gaps of ion spectral intensity in the inner magnetosphere (as was done by C.McIlwain, 1972, 1986). For this purpose a collection of several long intervals of very quiet conditions (Kp index was 0-1 during 2-3 preceding days) were selected from ION and SKA-3 particle measurements. Such events are of interest because, first, observed convection pattern was stationary, and second, characteristic time for such gap formation is rather long, of order of many hours. Ion drift trajectories from the near tail to the evening and dayside magnetosphere which produce ion narrow spectral gaps are modeled to test the validity of several known electric field models. A tentative extension of the global convection model by Senior et al. (1990) till the plasmopause is constructed and compared with ion narrow spectral gaps.

Paper Number: Ring.11

**THE MAGNETOSPHERIC DYNAMICS UNDER DISTURBED CONDITIONS
ON 23-27 NOVEMBER 1986****V.V. KALEGAEV, I.I. ALEXEEV, E.S. BELENKAYA***Institute of Nuclear Physics, Moscow State University, Moscow, 119899, Russia***YA.I. FELDSTEIN***IZMIRAN, Troitsk, 142092, Moscow Region, Russia*

The magnetospheric magnetic field is highly time-dependent and may undergo rapid changes (magnetospheric substorms and geomagnetic storms). These are events during which the most interesting magnetospheric physics phenomena (auroras, precipitations at high latitudes, acceleration of particle beams in the geotail etc.) occur. The dynamics of magnetospheric large-scale current systems was studied for the case of magnetic storm on 23-27 November 1986 using the dynamic paraboloid model and data of on-ground and satellite measurements.

A set of "submodels" calculating the magnetospheric current systems response to the changes in solar wind conditions was developed. The magnetic field variations at the Earth's surface as well as on the geostationary orbit are calculated and compared with the Dst and GOES 6 measurements respectively. Comparison of independently obtained magnetopause currents, ring current and geotail currents contributions into Dst shows that they are about one order.

The energy stored in geotail is calculated in terms of paraboloid model. It correlates strongly with the energy flow in the magnetosphere generated by solar wind - magnetosphere dynamo. The total energy of ring current particles is calculated using data of AMPTE/CCE measurements. It was shown that this energy increases when auroral activity diminishes. During substorm activity energy stored in the magnetotail transports mainly to the auroral ionosphere.

Paper Number: Ring.12

**RADIATION DYNAMICS ONBOARD MIR STATION
DURING GEOMAGNETIC DISTURBED PERIODS IN 1998**

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We present in the paper variations of penetrated radiation (>5 MeV electrons and >60 MeV protons) and high energy electron (>0.1 MeV) fluxes observed in Riabina experiment onboard MIR station in 1998. Riabina experiment data is presented on <http://dec1.npi.msu.su/~rtmir/> in about real-time regime. Several enhancements of radiation fluxes were observed during the period January-November 1998. The strong increasing of high energy electron intensity in the outer electron belt ($L>2.5$) and in the slot region ($L=2-2.5$) were observed. These enhancements of radiation onboard MIR station are related to the geomagnetic disturbed periods and developed on the recovery phase of magnetic storms.

Paper Number: Ring.13

SOME FEATURES OF GEOSTATIONARY ORBIT PLASMA PRESSURE

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Plasma pressure is one of the main parameter determining magnetosphere dynamics. Up to now only fragmented information exists on plasma pressure variations near the inner plasma sheet boundary. The geostationary orbit region represents the especial interest as the region of the interaction of the inner plasma sheet, the ring current and the outer radiation belt. Calculating plasma pressure was made using experimental data on ion and electron fluxes at the energy range from 0.1 to 133 keV obtained from the Gorizont-35 geostationary satellite. Plasma pressure variations were studied for two time periods: March 11-25 1992 and September 10-30, 1992. It was suggested that quiet time particle fluxes are near to isotropic. The obtained results evidences about the dominant contribution of low energy particles into the total plasma pressure. The averaged value of the calculated pressure (about 1 nPa) points to the important role of the geostationary plasma population in the formation of the magnetosphere pressure balance.

The work has been supported by the RFBR grant 97-02-16870.

Paper Number: Ring.14

Session II:

Tail and Substorm

THIN CURRENT SHEET IN THE INNER TAIL AND MIDTAIL
PRIOR TO THE SUBSTORM ONSET

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Multi-spacecraft observations are analyzed to examine the dynamics of thin current sheet evolution during the early phases of a substorm during the period 0630–0800 UT on Dec 10, 1996. The ground signatures showed two activations, one latitudinally localized at 0731 UT and another, larger expansion around 0800 UT. INTERBALL Tail Probe and GEOTAIL were both in the pre-midnight sector magnetotail, INTERBALL in the lobe and GEOTAIL mostly within the plasma sheet. A local model consisting of two current sheets (a thin current sheet and a thicker plasma sheet) was developed utilizing magnetic field measurements from these two spacecraft. Extension of the thin current sheet model to the inner magnetotail shows that during most of the growth phase, the thin current sheet intensified simultaneously and at the same rate in the mid-magnetotail ($\sim 30 R_E$) and near geosynchronous orbit. These results show that the thin current sheet extended from the near-geostationary region to the midtail, and that the entire current sheet responded to the driving in a coherent way.

Paper Number: SB.01

**INHERENT IMPULSIVE AND SPATIALLY LOCALIZED SUBSTORM FEATURES
DEDUCED FROM CORRELATED SPACECRAFT AND GROUND OBSERVATIONS**

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We present recent results of coordinated substorm studies which emphasize localized and impulsive nature of basic substorm related dissipation process.

- 1 Two spacecraft comparisons evidence that during global substorm unloading phase (with both polar cap size and lobe magnetic field decreased) the plasma heating does not occupy the whole plasma sheet. The open flux reconnection occurs in the localized sector occupied by the substorm current wedge (current disruption).
- 2 Direct snapshots of impulsive acceleration process in the equatorial plasma sheet, multiple sporadic velocity dispersed ion beams (SVDIS), are systematically observed at $h \sim 2 R_E$ by Interball/Auroral spacecraft in the auroral bulge, allowing to connect the ionospheric and plasma sheet events in the course of substorm expansion. Their correlation with auroral intensifications at the poleward edge of the bulge confirms association of SVDIS with temporal evolution of impulsive reconnection in the tail. A 2-3 min repetition period of these ~ 1 min scale activations shows some fundamental time constants of the substorm instability.

However, we also present evidence that this impulsive acceleration also occupies the closed plasma sheet tubes (CPS), so that inward propagation of fast waves launched by the braking of the reconnection induced fast flows is also required to form the SVDIS.

Paper Number: SB.02

**PROPERTIES OF SMALL SUBSTORMS
REGISTERED UNDER QUIET GEOMAGNETIC CONDITIONS**

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We present a survey of small substorms registered by IMAGE ground network, INTERBALL-TAIL and Geotail spacecraft during quiet (contracted oval) geomagnetic conditions. These substorms are associated with the weak solar wind energy input of order of $\sim 3 \cdot 10^{14}$ Joules and very small negative or positive IMF B_z values. Geomagnetic signatures are very localized and have amplitudes of about ~ 200 nT. During most of substorms magnetotail pressure decrease was observed simultaneously or before negative bays on the ground. We conclude that our observations support reconnection-based substorm model. However, contrary to big (classical) substorms which can be interpreted as global magnetotail catastrophes, smaller substorms appear to have signatures of only local catastrophe.

Paper Number: SB.03

**PLASMASHEET RESPONSE TO MULTIPLE SUBSTORM ACTIVATIONS:
SIMILARITIES AND DISCREPANCIES IN A SERIES OF CONSECUTIVE SUBSTORMS**

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On 9 December 1995 the Interball Tail probe passed inbound through the midnight sector of the plasmasheet (PS) encountering at $x=-10$ to $x=-12 R_E$ a few sequences of magnetic field stretching, PS thinning, exit to the lobe and re-entry into the PS due to PS expansion/dipolarization. Each sequence was well correlated with the vortex-like equivalent substorm current structures, Pi2 and PiB magnetic pulsations and other substorm parameters observed in the conjugate area in northern Scandinavia, although most of them had very weak ground magnetic effects and were localized to latitudes of a contracted oval. Details of the PS response to multiple substorm activations are explored in a contrasting manner by comparing values and behavior of available substorm parameters in the series of consecutive substorms/activations.

Paper Number: SB.04

**SELF-CONSISTENT STRUCTURE OF ANISOTROPIC CURRENT SHEET
WITH QUASIADIABATIC ION DYNAMICS****H.V. MALOVA, M.I. SITNOV***Institute of Nuclear Physics, Moscow State University, Moscow, Russia***L.M. ZELENYI***Space Research Institute of RAS, Moscow, 117810, Russia*

The thin anisotropic ion current sheets are the important element of magnetospheric dynamics and structure. The unified analytical theory of the self-consistent currents sheets created by the impinging ion streams from plasma mantle is considered. Nonlocal analogue of the Grad-Shafranov equation for the sources of arbitrary anisotropy is obtained in quasiadiabatic approximation, i.e. neglecting the jumps of the adiabatic invariant I_z of nonmagnetized ions, and solved numerically. The universal solutions modeling all possible regimes of strong and weak anisotropies are investigated. Resulting self-consistent current is a sum of the drift cyclotron current and the magnetization currents flowing in the opposite directions. The maximum thickness of the current sheet is achieved in a case of weak anisotropy and equals to the thermal gyroradius of ions outside the sheet. In a case of strong anisotropy the sheet is compressed to minimal thickness. We consider also the effects of real nonadiabaticity when the quasiadiabatic approximation is violated. Jumps of quasiadiabatic invariant I_z result in the gradual suppression of anisotropy and smearing of the current sheet. Influence of electron component creates an additional layer which also effectively broadens the current structure. We also discuss the relevant experimental data from ISEE and modern ISTP spacecraft (Geotail, INTERBALL) about the structure of the current sheets in the distant and near Earth parts of the tail.

Paper Number: SB.05**NON-ADIABATIC PARTICLE DYNAMICS AND MAGNETIC FIELD RECONNECTION
BY THE LINEAR MAGNETOSONIC WAVE EXCITATION IN THE CURRENT SHEET
OF THE EARTH'S MAGNETOTAIL****A.P. KROPOTKIN AND O.O. TRUBACHEV***Institute of Nuclear Physics, Moscow State University, Moscow, Russia*

A substorm onset instability suggested in this work combines the features of "macro" scale electromagnetic disturbance of the tearing mode type, and the "micro" scale plasma processes which provide necessary dissipation for the magnetic field reconnection process. The effect is based on linear excitation of the fast magnetosonic wave in non-uniform medium that consists of the current-carrying hot plasma sheet and the uniform cold background plasma. Such excitation has a low threshold, and does not need any preliminary turbulence level. The wave being excited interacts with particles dynamically resulting in a non-adiabatic and dissipative force due to the wave-particle momentum exchange. Such force does not exist in the Hamilton dynamics of test particles but is an important point of the self-consistent plasma systems analysis. As a result the limitations imposed earlier on the tearing-like instabilities are weakened.

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Paper Number: SB.06

**FAST EARTHWARD PLASMA FLOWS OBSERVED IN THE MID/DISTANT TAIL
UNDER QUIET CONDITIONS: RELATION TO SUBSTORMS**

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Measurements of the magnetic field and low energy plasma by the GEOTAIL spacecraft have been used to study fast earthward plasma flows in the distant (130-200 R_E) and middle (40-80 R_E) tail and their relation to substorms. State of the magnetosphere was estimated by the polar cap magnetic activity index PC, whereas the substorm onsets were determined by sharp increase of AE index. Results of the analysis show that high-speed earthward ion flows are often observed in the mid/distant tail under conditions of low magnetic activity (AE ~ 100 nT), when IMF B_z component is northward or oscillates about zero. The essential part of the fast earthward flows seems to be precursor of the substorm onsets on the Earth. These flows occur at closed magnetic field lines. The cause and effect relations between fast earthward plasma flows in the distant tail and substorm activity suggest that neutral line can form at distances far beyond 100 R_E in quiet conditions. The earthward plasma flows generated there can reach near-Earth plasma sheet and initiate processes leading to substorm development.

Paper Number: SB.07

**A SYSTEMATIC CORRELATED STUDY OF
VELOCITY DISPERSED ION BEAMS RELATED TO AURORAL SURGES,
FROM INTERBALL, POLAR AND GEOTAIL**

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As a general feature related to auroral surges in the midnight sector, Interball-2 systematically detect at altitudes on the order of $3 R_E$ impulsive ion injections in the 1 to > 15 keV range leading to multiple Velocity Dispersed Ion Structures (VDIS). Correlated UV measurements onboard POLAR and particle measurements onboard Interball-2 show that VDIS are first detected close to the northward boundary of the expanding auroral surge.

However VDIS are also detected well within the surge. Time of flight signatures of each VDIS lead to compute injection distances from the satellite ranging from about 8 to $30 R_E$. The VDIS quasi period, in the range of 1-5 minutes, should be related to the temporal characteristics of injection processes in the external magnetosphere. More deeply inside the plasma sheet i.e., more equatorward, bouncing ions are detected and lead to identify from bounce dispersions the initial injection (sometimes as close as $8 R_E$).

It must be noted that VDIS appears near the northward border of the auroral surge whatever is the time since substorm onset, thus indicating that the physical mechanism responsible for acceleration repeats as the surge is propagating northward. We try to interpret these observations in the framework of existing substorm model taking into account the detection of two types of Alfvén waves indicative of field line resonance and possibly of current sheet disruption in conjunction with VDIS and surge occurrence.

Paper Number: SB.08

MULTI-POINT SUBSTORM OBSERVATIONS
OF THE OUTER PLASMA SHEET DYNAMICS
ON NOVEMBER 13, 1996

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Response of the outer plasma sheet region to the substorm development on November 13, 1996 was studied with the plasma and magnetic field measurements obtained from INTERBALL-1, and GEOTAIL. In addition, the data from INTERBALL-2, LANL-080, -084 spacecraft and from Scandinavian and Siberian ground stations were used for the substorm timing. The solar wind and IMF which have been monitored by WIND spacecraft were rather variable during the early growth phase, but the remaining part of the growth phase as well as the expansion phase have been developed under stable southward IMF and relatively stable solar wind pressure.

Few unusual features of substorm evolution have been revealed in our study.

Measurements in the tail lobes and plasma sheet periphery during the growth phase showed that its behavior differs from a classical scheme.

Consideration of the total pressure behavior during the substorm at distances 22 and 27.5 R_E revealed cross-tail current substorm dynamics during the expansion phase. We concluded that current disruption impulsively propagated toward the tail from the near Earth plasma sheet region in accordance with the discrete character of the substorm development.

In the course of the substorm the signatures of tailward propagating plasmoid were observed at northern and southern parts of the plasma sheet first by INTERBALL-1 (at 28 R_E) and later by GEOTAIL (at 22 R_E). Time delay in the registration of the plasmoid at two-sides is hard to explain assuming the existence of only one plasmoid. This anomaly might be explained suggesting the asymmetric multiple plasmoid structure or (which is less probable) as signatures of completely different plasmoids.

During the late expansion phase despite the enhanced convection at the dayside magnetosphere, the effective dissipation of energy in the disrupting current sheet resulted in the magnetotail collapse and in the plasma mantle approach to the INTERBALL-1 position.

Paper Number: SB.09

**IDENTIFICATION OF THE TAIL PLASMA REGIMES
BASED ON VARIABILITY OF THE MAGNETIC FIELD AND PROTON FLUXES**

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Separation of the plasma regimes in the middle tail, namely the plasma sheet, the lobes, boundary layers, are studied. We develop the identification technique proposed in the papers [1], [2] and apply it to the Interball-1 data set. The separation is based on the primary plasma characteristics, i.e. on the magnetic field absolute value and sunward proton flux. Measurements made by the magnetometer MIF-M and the DOK-2 are used. The clustering algorithms are applied to the magnetic field phase space pictures and the values of the sunward proton fluxes.

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- 2 Eastman T.E., E.C. Roelof, S.P. Criston et al., Energetic proton flux anisotropy in the Earth's magnetotail, 2: Geotail EPIC observations, *J.Geophys.Res.*, 1998 (submitted).

Paper Number: SB.10

**DEVELOPMENT OF CURRENT DRIVEN INSTABILITIES AT PLASMA SHEET BOUNDARY
DURING SUBSTORMS: OBSERVATIONS FROM INTERBALL-2**

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• Electromagnetic fluctuations in the frequency range just below the proton gyrofrequency are commonly observed when the INTERBALL-2 s/c crosses the boundary between the polar cap and the auroral region, as well in the night and morning sectors. We study the main characteristics of these fluctuations: polarization, direction of propagation, E/B ratios... It leads to identify these waves as current driven instabilities which result from the differential velocity between ions and electrons in presence of a parallel electric field which develops at these boundaries. It will be shown that these waves which are driven unstable by electron drift provide energy to ions, thereby ensuring a collisionless dissipation of the current. It is suggested that this collisionless dissipation controls the development of larger scale processes such as surface waves at magnetospheric boundaries and interchanges/ballooning instabilities at substorms.

Paper Number: SB.11

SUBSTORM ONSET AS OBSERVED FROM THE GROUND AND SPACE

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To investigate the convergence of the substorm onset signatures and their reliability to describe adequately magnetospheric processes we study the substorm commencing at 2053 UT on Dec 15, 1996. It was observed by a number of ground based instruments and by two ISTP satellites Interball-1 and Geotail. For all selected data the time resolution was better than several seconds. Clear auroral breakup has been detected by several auroral TV cameras situated on Kola Peninsula and Scandinavia. Simultaneously several magnetic stations recorded the onset of magnetic bay and Pi2/PiB pulsations. Interball-1 situated in the tail lobe at $X=-10 R_E$ registered sharp decrease of the magnetic field strength, and a little bit later Geotail detected fast tailward plasma flow and bipolar variation of the magnetic field B_z component near the neutral sheet at $X=-23 R_E$. The study showed that when the observations are made in appropriate place both auroral and magnetic onset signatures occur at the same time. The observed sequence of magnetotail phenomena agrees with the onset scenario in which the current disruption occurs in the near-Earth plasma sheet in close relation to reconnection process and generation of tailward moving plasmoid.

Paper Number: SB.12STORM-TIME INJECTIONS OF 1-10 keV IONS
IN THE NEAR-EARTH PLASMA SHEET: AN IONOSPHERIC ORIGIN?D.C. DELCOURT, N. DUBOULOZ*CETP-CNRS, Saint-Maur des Fosses, France*

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During the expansion phase of substorms, the INTERBALL-Auroral spacecraft traveling across the auroral zone in the midnight sector often detects prominent structures of 1-10 keV ions that are dispersed in energy and latitude. On the poleward side of the auroral zone, these structures are characterized by repeated streaks of enhanced flux, the ion energy decreasing with latitude. These structures may result from impulsive reconfigurations of the magnetic field lines or from ExB filtering of downflowing particles. On the other hand on the equatorward side of the auroral zone, though a much less clear structuring is noticeable, multiple injections are still observed with an increase in average energy as latitude decreases. We focus on these latter dispersed ion signatures and show that they may be due to a rapid (on the time scale of expansion phase) circulation of ionospheric particles inside the plasma sheet. Measurements from the HYPERBOLOID experiment onboard INTERBALL lead us to consider a source of low-energy (a few tens of eV) ionospheric ions propagating poleward in conjunction with the auroral bulge. Using single-particle simulations, we demonstrate that these upflowing ions can have access to the mid-tail where they experience significant energization. As a result of magnetic moment scattering inside the current sheet, these particles subsequently flow down to low altitudes and are responsible for the populations detected at lower latitudes and higher energies (several keV) by the ION spectrometer.

Paper Number: SB.13

**CURRENT SHEET DURING THE SUBSTORM GROWTH PHASE -
COMPARISON OF OBSERVATIONS AND EVENT-ORIENTED MODELING**

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The Hybrid Input Algorithm (HIA) was used to model the magnetospheric configuration at the late growth phase. This algorithm allows one to tune the model parameters in order to fit the near-geosynchronous and low altitude spacecraft observations during individual substorms.

A few substorm events with favorably located spacecraft (GOES, INTERBALL, GEOTAIL, NOAA) have been modeled to infer the current sheet thickness and current density during the late growth phase. The maximal current density values obtained so far do not exceed 40 nA/m^2 , though the current sheet thickness appeared to be only about few tenths of earth radii at distances $8\text{-}12 R_E$. The direct current sheet thickness estimation of about $0.3 R_E$ was also obtained for the substorm on December 15, 1996, when GEOTAIL crossed the flapping neutral sheet just prior to the breakup.

The accuracy of mapping of spacecraft location to ionosphere with different models (T89 at different K_p and HIA model) is also considered for the event of December 15 1996. The results of mapping as well as tailward flows observed at GEOTAIL lead us to assume that the substorm was initiated earthward from GEOTAIL at distances less than $20 R_E$.

Paper Number: SB.14

**USE OF COORDINATED OBSERVATIONS FROM MULTIPLE SPACECRAFT AND GROUND
MAGNETIC DATA FOR MODELING AND DIAGNOSTICS OF MAGNETOSPHERIC
SUBSTORMS**

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A sequential approximation method based on coordinated observations from multiple spacecraft and ground magnetic data has been developed for estimation of the intensity and longitudinal distribution of the substorm current wedge (SCW), partial ring current (DRP), symmetric ring current (DR), positions of boundaries of the region of dipolarization during substorms. The modeling techniques applied to 20 substorm events.

Paper Number: SB.15

AMEI-2 OBSERVATIONS OF ION BEAMS
IN THE PLASMA SHEET BOUNDARY LAYER AND IN THE PLASMA SHEET

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The low energy plasma composition spectrometer AMEI-2 works successfully aboard INTERBALL-1 satellite since August 1995. The instrument is built to be able to find in the low energy range of the phase space (E, q, j) and separate the fluxes of the major ion species in the magnetotail - H^+ , He^{++} , He^+ and O^+ , and analyze their energy and angular distribution. It scans an energy range 0.3 - 10 keV/q, the energy bandpass being about 20%; with angular scanning by one angle, using the spin of the satellite to sample the other angle. Because of a failure in the flag circuit to SSNI, which happened before the instrument was switched on, the instrument's quota permits only several hours work per orbit so we fail to obtain full data coverage in the different plasma regimes.

During November - December 1995 when INTERBALL-1 was in the magnetotail, several northern lobe - plasma sheet transitions were registered by AMEI-2 instrument, which gave us the opportunity to investigate the plasma in the plasma sheet boundary layer. Presented and discussed are six cases with PSBL crossings beyond $X=-15 R_E$. The two November crossings - on 20 and 24 Nov and the Dec 21 case represent quite geomagnetic conditions. The observations on 5 and 17 December represent the PSBL and the PS in the stage of recovery after weak storm activity. On 9 December INTERBALL-1 met the PS when a more pronounced disturbance was developing, probably at the stage of PS thinning.

In all cases in the PSBL Earthward flowing proton beams lasting for several minutes are registered. Tailward beams when found are with less intensity. Most remarkable are the beams observed on 9 Dec when several Earthward very intense proton beams are observed, lasting for about 10 min, the particles having energies $>5\text{keV}$. One tailward beam is registered for 6 min, with a bit softer spectrum beginning at about 2 keV/q and with less intensity.

Paper Number: SB.16

MULTISATELLITE STUDY OF SHARP SOLAR WIND DISCONTINUITIES
AND THEIR SUBSTORM TRIGGERING EFFECT

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Detailed analysis of sharp South-North Solar Wind Discontinuities' (SWDs) orientation by different methods using multisatellite observations is carried out. Comparison of different methods is done. On the basis of the produced analysis the time of SWD contact with magnetopause is calculated and compared with times of polar cap reaction and substorm onset. Such timing makes it possible to distinguish triggered substorms from spontaneous ones. It is shown that for slanted discontinuities the substorm onset sometimes precedes the polar cap convection decrease, which confirms the statistical result of [Sergeev, Dmitrieva and Barkova, 1986].

Paper Number: SB.17

ROLE OF REGION 1 FIELD-ALIGNED CURRENTS IN SUBSTORM TRIGGERING**I.I. ALEXEEV AND S.YU. BOBROVNIKOV***Institute of Nuclear Physics, Moscow State University, Moscow, Russia*

The substorm onset was theoretically studied. It was described as a global transition from a metastable magnetospheric state to another stable state with lower energy. In contrary to the usual approach we investigate not local instability in the tail but global magnetospheric instability. Based on paraboloid model the magnetospheric dynamics during substorm growth phase was investigated. A key role of the Region 1 field-aligned currents was revealed. Critical values of the model parameters depend on intensity of field-aligned currents was calculated. It was shown that at growth phase, when the IMF has southward direction, the Region 1 field-aligned currents serve as a stabilization factor which permits the magnetosphere to go to the metastable configuration. And after IMF turns northward or a sudden pulse in solar wind dynamic pressure this stabilization factor disappears. The criteria of the transition of the magnetosphere from metastable configuration to expansion was presented. On the basis of this criteria the scenario of substorm which take into account an influence of field-aligned currents was constructed. This scenario is based on global magnetospheric model. Parameters of this model have obvious physical sense and can be calculated from the satellites and on-ground measurements. As a results a new explanation of substorm onset was presented.

Paper Number: SB.18

**INFLUENCE OF THE TAIL AND FIELD-ALIGNED CURRENTS
ON MAGNETOSPHERE DYNAMICS****IGOR I. ALEXEEV AND ELENA S. BELENKAYA***Institute of Nuclear Physics
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Contributions of the tail and field-aligned currents to the pressure balance in the subsolar point and at the inner edge of the plasma sheet are studied. In the dayside of the magnetosphere Region 1 field-aligned currents decrease the magnetic field strength. They move cusp to more lower latitude and improve the stability condition at the earthward edge of the plasma sheet. The tail currents contribution on the dayside magnetospheric magnetic field is the same as the Region 1 field-aligned currents contribution. But near the inner edge of the plasma sheet the tail currents field is opposite to magnetospheric field. The influence of the tail and field-aligned currents on magnetosphere dynamics is examined.

Paper Number: SB.19

ARTIFICIAL LOCALIZATION OF THE MAGNETOSPHERIC SUBSTORM
BY THE HF HEATING FACILITY

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Joint experiment using the INTERBALL-2 (AURORAL PROBE) satellite and the EISCAT ionospheric heating facility was carried out in October-November 1996. In this experiment, the HF emissions from Tromsø operated during the flight of INTERBALL-2 satellite over the auroral region in the flux tube with a footprint at Tromsø (Effective radiated power = 150 MW, carried frequency = 4.04 MHz) which was amplitude modulated at a frequency of 1733 Hz.

The most prominent effects were encountered on 27.10.96 around 21.31 UT during 7 minutes, just a few minutes before the onset of a magnetic substorm: i) DC electric and magnetic fields variations, ii) electromagnetic turbulence in the frequency range up to 10 Hz, iii) broad band VLF emission around modulation frequency and subharmonic, iv) burst of 0.1-6 keV electron and proton flux.

Ground based magnetic field measurements (IMAGE magnetometer network) showed significant magnetic field perturbation, which started a few minutes after the beginning of HF radiation. On the basis of ground measurements position and time evolution of the field-aligned current was registered just above heating facility.

The most probable scenario of the phenomenon is that the artificial disturbance of ionospheric conductivity increase the field-aligned currents in the selected magnetic flux tube. Substorm related vortex have been registered at the ground stations just few minutes after start of heating operation and the center of the vortex was almost exactly at Tromsø location.

Paper Number: SB.20

**THEORY OF LOCALIZED RESONANT OSCILLATIONS IN THE NIGHTSIDE
MAGNETOSPHERE EXCITED BY TIME-DEPENDENT ELECTRIC CURRENT IN HOT
MAGNETOTAIL PLASMA**

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A substorm onset instability suggested in this work combines the features of "macro" scale electromagnetic disturbance of the tearing mode type, and the "micro" scale plasma processes which provide necessary dissipation for the magnetic field reconnection process. The effect is based on linear excitation of the fast magnetosonic wave in non-uniform medium that consists of the current-carrying hot plasma sheet and the uniform cold background plasma. Such excitation has a low threshold, and does not need any preliminary turbulence level. The wave being excited interacts with particles dynamically resulting in a non-adiabatic and dissipative force due to the wave-particle momentum exchange. Such force does not exist in the Hamilton dynamics of test particles but is an important point of the self-consistent plasma systems analysis. As a result the limitations imposed earlier on the tearing-like instabilities are weakened.

Theory of transverse-small-scale Alfvén resonant waves is modified in order to use it for substorm phenomena modeling. Poloidal disturbances are considered, for which field-aligned currents are of substorm origin (belong to the substorm current wedge system), and polarization corresponds to the effects of magnetic "dipolarization" and increased plasma radial convection. Nonresonant components of the substorm disturbance in the near-Earth portion of the magnetotail plasma sheet are assumed to serve as an external source for Alfvén resonance generation. This occurs in the form of "extraneous" field-aligned currents on the poloidal resonant surfaces (PRS) arising due to spreading over the ionosphere of those disturbances which are brought there from the dipolarization region. Nonresonant constituent of the impulsive disturbance with continuum frequency spectrum excites simultaneously and in a coherent manner a lot of resonances at different PRS. During radial propagation, different resonant waves overlap, and their phase velocity differences result in phase mixing leading to the disturbance amplitude decrease without any dissipation in the ionosphere.

Results are applied to interpretation of the time-dependent substorm current wedge and Pi 2 pulsations. Another application is related to intense short-term inductive electric field of the resonant disturbance. Such a field may effectively accelerate energetic particles. Analysis of observational data (Baker and Pulkkinen, 1998) suggests that strong low-frequency (2 - 20 mHz) waves may be indeed responsible for such acceleration.

Paper Number: SB.21

PLASMA PRESSURE PROFILES IN THE MAGNETOTAIL: CASE STUDY

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Measurements of ion fluxes by PROMICS-3, CORALL and DOK-2 onboard INTERBALL-1 satellite give the possibility to restore the full distribution function of ions in the range from 20 eV up to 0.5 MeV and calculate the plasma pressure. The distribution of plasma pressure in the transition region between the ring current and the plasma sheet is investigated for a number of passes of INTERBALL-1 satellite. Directions of plasma pressure gradients are determined. The conducted analysis give the possibility to determine the direction of magnetostatically equilibrium transverse current in plasma, as earthward directed gradients produce westward current and anti-earthward directed gradient produce eastward current. It is shown that in some cases plasma pressure gradient has the tailward direction.

Paper Number: SB.22

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Cusp and Magnetopause

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CUSP STUDIES WITH INTERBALL

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The Interball project is unusually well suited for cusp and cleft studies. The orbits of Interball-1 and Magion-4 visit the cusp at several altitudes including the external cusp while the orbit of Interball-2 crosses the cusp at lower altitudes. In this paper cusp results from Interball will be reviewed. Interball measurements show that the cusp is a very persistent feature and that plasma entry from high latitudes is more important than has been generally thought before these data were available. Several studies using Interball data are shedding new light on the entry mechanisms. These include both sub-solar point reconnection, lobe reconnection and direct entry through the turbulent, low-B-field outer cusp region. Plasma also enters the magnetosphere through the cleft.

Paper Number: Cusp.01

ULF TURBULENCE AT THE MAGNETOSPHERIC BOUNDARIES
AND PLASMA TRANSPORT PROCESSES

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Interball-1 detected ULF wave energy densities in the shocked solar wind and outer magnetosphere up to some tenths of the solar wind kinetic energy density. We make use of characteristic wave and field signatures, both on the magnetospheric frontside and in the nearest tail, for the determination of the scales of the fluctuations and for the study of their influence on the transport processes across the magnetospheric boundaries. In such regions as cusp, outer cusp throat, mantle, MSH, LLBL the particle heating and anomalous transport are controlled by Alfvénic vortices. Near the cusp magnetopause the Alfvénic vortices provide substantial part in the total energy balance. In the most characteristic regions the waves constitute intermediate chains for the energy transformation and effective resistance for the magnetospheric current dissipation and respective magnetic field reconfigurations. The wave packets with amplitudes up to 5 mV/m and 10 nT have characteristic scales of 1-1000 km.

Paper Number: Cusp.02

USING ISTP SPACECRAFT IN CUSP AND BOUNDARY LAYER STUDIES**B. POPIELAWSKA, I. SANDAHL***Swedish Institute of Space Physics, Kiruna Sweden***A.V. ZAKHAROV***Space Research Institute of RAS, Moscow, 117810, Russia***V. PETROV***Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation of RAS,
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PROMICS-3 plasma instrument on Interball-Aurora is designed to measure energy spectra of ions and electrons and the ion mass composition in the energy range 10 eV-30 keV. To be a valuable data provider for correlated multipoint studies of the Earth's magnetosphere PROMICS-3 needs a cross-calibration with other similar plasma instruments. We present results of comparison of PROMICS-3 data in the cusp, the mantle/LLBL and the hot plasma sheet with the conjugated nearly simultaneous ($dt < 15$ min) plasma measurements by Fast and Polar satellites. As an example of possible correlated investigations this trio of satellites will be used to study how medium duration pulses of the solar wind dynamic pressure are transmitted through boundary plasma regions of the magnetosphere.

Paper Number: Cusp.03

**SIMULTANEOUS OBSERVATIONS OF THE DAYSIDE MAGNETOPAUSE AND POLAR CUSP
WITH INTERBALL TAIL AND POLAR****D.L. DEMPSEY***Rice University, Houston, Texas**also at: Southwest Research Institute, San Antonio, Texas***J.H. WAITE, JR., J.L. BURCH, A.H. MENKE, III***Southwest Research Institute, San Antonio, Texas***L.A. AVANOV, O.L. VAISBERG, V.N. SMIRNOV, A.A. SKALSKY***Space Research Institute of RAS, Moscow, 117810, Russia***A. FUSELIER***Lockheed Martin Advanced Technology Center, Palo Alto, California*

Conjunctions when Russia's Interball spacecraft traveled through the magnetosheath near the dayside magnetopause and NASA's Polar spacecraft simultaneously traversed the northern cusp have been studied. Changes in the $\text{He}^{2+}/\text{H}^{+}$ density ratio in the cusp are observed by Polar. Observations are made of the conditions at the dayside magnetopause using moments data from the SCA-1 instrument and magnetic field data from the MIF instrument on Interball Tail. Temporal changes in the density ratio in the cusp and variations in conditions at the dayside magnetopause are both shown to be associated with the reconnection rate and are hence shown to be related. Results from several conjunction events are compared and contrasted to the results of an April 13, 1996, conjunction in which temporal variations in the cusp data observed by Polar were shown to be on the same time scale as oscillations of the dayside magnetopause observed by Interball Tail.

Paper Number: Cusp.04

**PLASMA CHARACTERISTICS IN THE EXTERIOR CUSP REGION
UNDER DIFFERENT IMF CONDITIONS.
THE INTERBALL-TAIL OBSERVATIONS AND NUMERICAL SIMULATION**

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We present the observations of plasma flow in the exterior cusp in the vicinity of the magnetopause made by Interball-Tail satellite for different directions of IMF. Under southward IMF three types of ion distribution function observed in magnetospheric parts of magnetic field lines (torus-like, pancake and D-shaped) display a gradually decreasing ion entry along 'old' reconnected magnetic field lines. Under northward IMF D-shaped distributions with varying cutoff velocity parallel to the magnetic field are observed. Such distributions are typical for particles injected along recently reconnected magnetic field lines.

We also present the results of a simulation that uses Toffoletto-Hill model of the open magnetosphere to trace the particles from the magnetosheath to magnetospheric locations of Interball. The simulation successfully reproduces features of measured distribution functions.

Study of plasma behavior shows that the entry of magnetosheath plasma into the magnetosphere can be described in terms of reconnection and open topology of field lines near the exterior cusp.

Paper Number: Cusp.05

**REMOTE ANALYSIS OF CLEFT ION ACCELERATION USING THERMAL PLASMA
MEASUREMENTS FROM INTERBALL AURORAL PROBE**

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Three dimensional distributions of low energy (0-80 eV) ions have been obtained in the high-latitude dayside sector between 10,000 and 20,000 km by the Hyperboloid experiment onboard Interball-Auroral Probe. H⁺, He⁺ and O⁺ ions exhibit a latitude-energy dispersion characteristic of the cleft fountain. Test particle simulations are used to investigate the properties of the outflowing ion source region. Regardless of ion mass, it is shown that the bulk of the outflowing population originates from a narrow (< 2°) latitudinal interval inside the dayside cleft. Ion acceleration in the direction perpendicular to the magnetic field is shown to occur at all altitudes at least up to 10,000 km, that is, higher than previously reported in cleft fountain studies. The simulations clearly display a gradual decrease of the heating efficiency with increasing altitude and suggest a weaker gradient for O⁺ than for H⁺. Several events will be considered, also including conjugated measurements by the Timas experiment on Polar and by Super-Darn radars.

Paper Number: Cusp.06

**APPLICATION OF THE WAVELET ANALYSIS FOR WAVE FORM
TAKEN IN THE POLAR CUSP ONBOARD INTERBALL 1 AND MAGION 5**

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During polar cusp crossing by IT 1 and Magion 5 the wave form has been transmitted occasionally. The FFT analysis indicated many burst of ULF emissions in both electric and magnetic components. These waves has highly non stationary characters. To study the dynamics of changes in the spectral characteristics of the waves we decided to use wavelet analysis. In this presentation the results of the analysis for selected cusp crossings at different altitudes will be given.

Paper Number: Cusp.07

**ALMOST MONOENERGETIC IONS
NEAR THE EARTH'S MAGNETOSPHERE BOUNDARIES:
THE CASE STUDY**

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Energetic ion events with spectra consisting of 1-3 narrow lines were discovered in DOK-2 experiment onboard of the Interball-1 spacecraft in 1995-1998. The statistical study of properties of Almost Monoenergetic Ion (AMI) events showed that they can be a result of the solar wind ion acceleration in the burst of electrostatic field on the magnetopause or on the bow shock. To find out which of these two possibilities is realized we made a detailed study of several events in the magnetosheath and in the solar wind near the bow shock together with the magnetic field, plasma and attitude data. The data are for the April 14-16, 1996 period. While the short duration of AMI (~ 1 min) complicates the pitch angle distribution measurements our analysis showed that these distributions are rather narrow (FWHM of $\sim 30^\circ$) and have the maximum close to 90° . In some cases the angular distributions were nongyrotropic indicating the possible vicinity of the acceleration region or the large space gradient of the ion density. The analysis of the magnetic field direction in the observation point showed that at least in some cases there was no MF connection with the model magnetopause (within one gyrodiameter) which argue against the magnetopause as the possible acceleration place. This problem needs further study.

Paper Number: Cusp.08

**THE MAGNETOSPHERIC MAGNETIC FIELD IN THE HIGH-ALTITUDE CUSP REGION.
THE COMPARISON OF INTERBALL-TAIL MEASUREMENTS
AND T96 MODEL PREDICTIONS**

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It is well-known, that Tsyganenko96 model fails to describe the topology of magnetic field in the exterior cusp region. Recent observations of Polar spacecraft allowed to adjust the model at the middle altitudes. We performed the comparison of T96 model and Interball measurements in the cusp region adjacent to the magnetopause. The observations show the significant deviation of model from real magnetic field. The attempt to find the additional current responsible for this deviation was made.

Paper Number: Cusp.09

**STUDY OF THE PROPERTIES AND DYNAMICS OF ENERGETIC PARTICLES
AT MEDIUM AND LOW ALTITUDES NEAR THE DAYSIDE CUSP REGION:
MEASUREMENTS FROM INTERBALL-2 AND INTERCOSMOS-24**

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Recently, POLAR satellite observations of energetic (up to hundreds of keV) particles in the dayside cusp region at altitudes $\sim 8-9 R_E$ were reported. Nowadays, sources of energetic particles in the outer cusp are being discussed. The outer cusp region may be the source of energetic particles at high latitudes and relatively low altitudes in dayside magnetosphere. Measurements from low-apogee (~ 2000 km) satellite Interkosmos-24 at high latitudes poleward of the auroral precipitation boundary revealed the presence of isolated low-intensity peaks of energetic (≥ 20 keV) electrons within pitch angle range from 90° to the local loss cone. The peaks were observed in local time sectors from 7 to 14 MLT. Here we present the description of Interkosmos-24 data, and their comparison with other measurements performed in this region. In particular, Interball-2 data are analyzed to investigate properties and dynamics of energetic particles at medium altitudes in the dayside cusp and cleft regions.

Paper Number: Cusp.10

**CHARGED PARTICLES TRAPPING
IN THE REGION OF LOCAL MAGNETIC FIELD MINIMUM IN THE EXTERIOR CUSP**

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The models of magnetospheric magnetic field predict the local field minimum along the field lines passing through the exterior cusp near the magnetopause. The bouncing motion of particles could be observed in this region. Such trapped particles have been recently found by POLAR. The INTERBALL data was used for detail analysis of the location of the region of trapping and ion population there. The sharp trap boundary was defined. Its location was compared with the Tsyganenko96 model predictions. This work was supported by RFFI grants 98-02-17402, 96-05-64534.

Paper Number: Cusp.11

**RECONSTRUCTION OF THE FIELD-ALIGNED CURRENT STRUCTURE
ALONG SPACECRAFT TRAJECTORY WITH REGARD FOR EDGE EFFECTS
OF CURRENT SHEETS**

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Numerical method of reconstruction of the field-aligned currents taking into account both, zonal and meridional, components of magnetic disturbances observed along the spacecraft trajectory has been developed. While the zonal component of magnetic field testifies to number and latitude location of the field-aligned current sheets, the meridional component is the evidence of edges of the current sheets. The last circumstance is important for the day-time cusp region where Region 1 FAC currents are terminated in the vicinity of the noon meridian whereas the current sheets located poleward of the Region 1 (i.e. cusp currents) are evidently confined to limited MLT sector. The model simulation was used to derive general regularities in the latitudinal variation of zonal and meridional components in cases of one, two, three and four longitudinally limited current sheets, two-dimensional equation for vector magnetic potential being solved numerically in spherical coordinates. Latitudinal variations observed by the AUREOL-3 are compared with model ones, and parameters of the current model are modified so that both curves match best. The optimal current sheet parameters providing similarity of observed and model variations for zonal and meridional components are determined by method of gradient descent in solving of system of equations for local minimums for each parameter. Magnetic field perturbations observed by the AUREOL-3 spacecraft in the day-time region near the noon meridian were used as experimental basis. The current patterns consistent with the observed features of magnetic perturbations for IMF conditions $B_z > 0$ and $B_y < 0$ have the following main structures: a sheet of upward current at latitudes 70-75 degrees, a sheet of downward currents at latitudes 78-80 degrees, and the third current sheet at latitudes above 80 degrees. The first two sheets are extended from dusk and terminated near the noon meridian, the third sheet consists of downward currents in the post-noon sector and upward currents in the pre-noon sector. These current sheets can be identified as FAC Region 2, Region 1, and Region 0 (cusp), correspondingly. It implies availability of only one additional current sheet poleward of Region 1 under conditions of the northward IMF.

Paper Number: Cusp.12

**SUPERHERMAL DOWNWARD MOVING ION DISPERSED POPULATION
IN CUSP AND LLBL****V.V. VOVCHENKO***Space Research Institute of RAS, Moscow, 117810, Russia*

Besides the well-known velocity-dispersed keV - range ions (VDIS) regularly observed in particular from VIKING and INTERBALL-2 in the plasma flux tubes of the cusp and LLBL, a new ion dispersed population is sometimes found at superthermal energies which is downward moving in these regions. The data from SKA-3 instrument during a widespread burst of energetic electrons (Shuiskaya et al., 1998) have shown a nearly simultaneous appearance at altitude $3 R_E$ of perpendicularly heated/accelerated superthermal ions of 30 eV. Such local ion heating/acceleration phenomena are studied now in more details from the data of SKA-3 and HYPERBOLOID spectrometers onboard the INTERBALL-2. The observed velocity dispersions of V - shape indicate burst - type processes at altitudes up to $4-6 R_E$ that can inject downward the H^+ and He^+ ions of 10-50 eV. Possible models of the source are discussed.

Paper Number: Cusp.13

A SIMPLE MODEL OF THE CUSP REGION 0 FIELD-ALIGNED CURRENTS**YU. GALPERIN***Space Research Institute of RAS, Moscow, 117810, Russia*

Satellite measurements show highly variable pattern of the field-aligned currents (FAC) within the cusp region. A feature which is more or less general in most of the statistical studies is the presence of a specific cusp current system localized near the noon meridian poleward from the Region 1 FACs - the so-called Region 0 FAC. It has upward FAC on its pre-noon side and downward FAC at its post-noon side. It can shift in MLT in response to IMF B_Y , but probably exists both for negative and positive B_Z . However, local variations of cusp FACs often are strong enough, so that this FAC system is difficult to discern on a single satellite cusp crossing. A simple model of the Region 0 FAC system is suggested.

Paper Number: Cusp.14

EXPERIMENTAL EVIDENCE OF THE
ION-CYCLOTRON WAVES GENERATION AND ABSORPTION
IN THE EARTH CUSP REGION

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The wave observation onboard INTERBALL and POLAR satellites in the Earth cusp region on May 29, 1996 have been used for the investigation of the low frequency plasma waves generation and absorption. A consistent vector approach was applied for the Fourier analysis of the magnetic and electric field wave forms that has allowed to obtain the wave vector and the Poynting vector angular distributions and to determine polarization states of the waves under study. This analysis has shown the low frequency radiation at the cusp boundary consists of discrete wave packets. The central frequencies of them in many cases are corresponding to the local ion-cyclotron frequencies. At the magnetosphere-cusp boundary the satellite has been occurred alternately at the magnetic field lines belonging to the magnetosphere. The Fourier spectrums of the electric and magnetic field fluctuations measured in this time contain the clear absorption lines at the proton-cyclotron frequency and its harmonics. The spectral peculiarities as well as the found angle distributions of the wave and the Poynting vectors gave the common picture of plasma wave activity in the cusp such as the next. At the outset the MHD turbulence is arising with typical power spectral density proportional to $f^{-\nu}$ following from the plasma flow breaking and turning in the cusp region at their boundary. An interaction these waves with the quasi-trapped ions results in the inducted radiation or in the wave energy absorption at the resonant ion-cyclotron frequencies in dependence on the ion distribution function.

Paper Number: Cusp.15

ENERGETIC PARTICLES TRAPPED IN THE HIGH-LATITUDE
OUTER GEOMAGNETOSPHERE

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Model concept of energetic particle trapping in the high-latitude outer dayside magnetosphere associated with off-equatorial field minima, existing both on closed and on open field lines, has been proposed long ago (Shabansky, 1972; Shabansky and Antonova, 1968; Antonova and Shabansky, 1975, 1976). Aside from the observational evidence of energetic particle enhancements in the corresponding regions which were obtained on the ELECTRON, IMP 3 and PROGNOZ 3, 7 and 9 S/C and were analyzed earlier, recent observations of energetic heavy ions, protons and electrons in the dayside polar cusp onboard INTERBALL (Savin et al., 1998) and POLAR (Chen et al., 1997, 1998; Sheldon et al., 1998) are shown to support the model (Antonova et al., 1998).

A plausible origin mechanism for the dayside high-latitude particle fluxes consists of: (a) particle injection (and possible acceleration) during magnetospheric substorm activity on nightside; (b) drift-shell branching effect bringing near-equatorial (at nightside) particles to dayside high-latitude regions; (c) pitch-angle and cross-drift-shell diffusion of particles which eventually produce the locally trapped population.

Paper Number: Cusp.16

Session IV:

LLBL and Magnetopause

A COUPLED STUDY OF LLBL DYNAMICS
NEAR THE MAGNETOSPHERIC EQUATORIAL PLANE AND OF
IMPULSIVE ION INJECTIONS AT THE POLAR EDGE
OF THE AURORAL OVAL

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We correlate impulsive ion injections detected, onboard Interball-2, at the polar edge of the auroral oval with LLBL dynamics as measured onboard Interball-1 near the flank of the magnetosphere and with magnetosheath plasma measurements taken onboard Geotail. Over the auroral zone, these events are characterized by overlapping energy dispersed structures of ions from several hundred eV to about 10 keV. Energy spectra are quite similar to these of the cusp. However the fluxes are here about 10 times weaker.

From the shape of the energy/pitch angle ion structures, due to time of flight effect, we determined the location of the sources in the external magnetosphere: the dawn/dusk magnetospheric LLBL at distances ranging from 13 to 23 Re. The time delay between Interball-2 observations and initial injections is computed to correlate auroral events with magnetosheath measurements performed onboard Geotail. Correlations show that these LLBL/magnetosheath injections are related to magnetosheath pressure pulses. LLBL multiple encounters by Interball-1 near the equatorial plane, generally encountered for northward IMF, also show a good correlation with pressure pulses.

From these coupled observations we propose a scenario of impulsive plasma penetration from the magnetosheath to the magnetosphere.

Paper Number: Mbp.01

**STUDY OF THE FLANK LLBL PROPERTIES AND FORMATION MECHANISMS
IN THE WIDE LATITUDE RANGE AND UNDER DIFFERENT IMF CONDITIONS.
INTERBALL-TAIL OBSERVATIONS**

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The Low Latitude Boundary Layer (LLBL) is one of the important plasma and energy transition region between magnetosheath and magnetosphere. The mechanism of LLBL formation is strongly dependent on IMF direction and is unclear until now. Interball-Tail Probe was surveying the LLBL regions during 1995-1998. We used this data to investigate latitudinal distribution of LLBL and to identify the open-closed boundary in the magnetotail. We studied the formation of LLBL at open reconnected and closed (possibly double reconnected) field lines under different IMF directions. We present the evolution of plasma characteristics across the LLBL from magnetopause down to plasmashet. The appearance of ionospheric ions in the LLBL at the plasmashet edge of LLBL is discussed.

This work was supported by INTAS grants 94-2638 and 96-2346.

Paper Number: Mbp.02

**MAGNETOPAUSE STRUCTURE IN THE TANGENTIAL DISCONTINUITY CASE:
IS EQUILIBRIUM POSSIBLE, AND WHAT HAPPENS IF IT IS NOT?**

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We have considered the case of a magnetopause that is locally in a state of tangential discontinuity (TD) equilibrium. Using a kinetic TD model and a model for the magnetosheath flow around the magnetopause, we have been able to identify, for a prescribed rotation angle of the magnetic field, where the magnetopause can be in a state of TD equilibrium, and where it cannot. One of our findings is that there can be no TD equilibrium for low magnetic shear dawnside crossings. The magnetopause then should have another equilibrium structure (e.g., it may be a rotational discontinuity) or it may be intrinsically not in equilibrium (macro-turbulence); all these alternatives suggest a magnetopause that would permit plasma transfer across the boundary. Indeed, INTERBALL observations have revealed the existence of a very wide LLBL at the dawnside for northward IMF.

Paper Number: Mbp.03

PLASMA TRANSIENTS IN LLBL AS OBSERVED WITH INTERBALL TAIL PROBE

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Plasma transients are frequently observed in the Low Latitude Boundary Layer at magnetospheric flanks. These are bursts of magnetosheath-like plasma with diminished density and elevated temperature. These plasma transients are nearly-monotonically evolving: convective velocity and number density diminish, and temperature increases with the distance from magnetopause. While evolving they keep double structure with cooler, denser, and faster leading part compared to the trailing part. Appearance of these plasma transients is more frequent when magnetospheric and interplanetary magnetic fields have antiparallel components and are frequently accompanied by the phenomena typical to reconnection: velocity jumps in magnetosheath flow adjacent to magnetopause and the magnetospheric particle leakage to magnetosheath. Some of the plasma transients in LLBL have FTE magnetic structure with the site of the normal components magnetic field change of sign coinciding with the separation between the leading and trailing parts of the plasma transient. We analyze the structure of magnetospheric plasma transients observed with high-time resolution of 3-D ion spectrometer SCA-1 on the Interball Tail Probe. We concluded that many of these plasma transients, formed as result of sporadic reconnection, and are plasma parcels disconnected from the magnetopause, that propagate and dissipate in the magnetosphere, forming Disconnected Magnetosheath Transfer Events (DMTEs).

Paper Number: Mbp.04

THE CAUSES AND THE AMPLITUDE OF THE MAGNETOPAUSE MOTIONS

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The high latitude magnetopause motions were investigated on the base of the multi-spacecraft measurements. Comparing data from INTERBALL-1 satellite, its subsatellite MAGION-4 (separated by distance about 1.5 Re) and the WIND served as a solar wind monitor allowed us to estimate the amplitudes of the fast magnetopause motions and their dependence on the external conditions.

As result of this study it was shown that the short-time (at the range 10 sec-10 min) oscillations of the magnetopause can be explained rather by the large enough amplitude variations of the dynamic pressure of magnetosheath plasma (near the magnetopause) than by simultaneous variations of the solar wind pressure and the magnetic field because the amplitudes of the last ones are too small.

Paper Number: Mbp.05

PLASMAS BOUNDARY AT THE MAGNETOPAUSE

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Investigation of motions of the two sorts of collisionless plasma (magnetosheath and magnetospheric) in strong magnetic fields allows to construct a model of the low-latitude dayside magnetopause consisting of two current layers. For southward IMF, both currents flow from noon to dusk. This is a metastable configuration, in which reconnection may occur. For northward IMF, the current created by the magnetosheath ions is directed to dusk, and the current generated by the magnetospheric ions is directed to dawn. A mechanism of a double-current layer generation at the dayside low-latitude magnetopause is connected with the difference of plasma parameters and magnetic fields in the magnetosheath and in the magnetosphere. The direction of charged particles gyration at the magnetopause is such that the magnetic field generated by each boundary current creates diamagnetic effect.

Paper Number: Mbp.06THE 24-TH JULY EVENT OF GROSS MAGNETOPAUSE DEFORMATION
AS EVIDENCE OF IMF RECONNECTION PROCESSES
(ON BASE OF GROUND-BASED MAGNETIC DATA)T.V. KUZNETSOVA , V.I. ODINTSOV, A.N. ZATSEV*IZMIRAN, Troitsk, 142092, Russia*

Data from ground-based observatories for interpretation of the 24-th of July, 1996 event of gross magnetopause deformation derived from unique Interball-1 measurements by other authors are attracted. Analysis of a set of magnetic stations shows that the largest changes in H-component (during discussed time) are observed at the observatories placed under dayside polar cusp (Godhavn, $F_g=79.3^\circ$, $L_g=34.5^\circ$ and others). Study of the geomagnetic data of those observatories that allow to determine sign of the IMF sector structure (Thule and others) shows that during examined event sector structure changed his direction (from $B_x \text{ IMF} > 0$, $B_y \text{ IMF} < 0$ to $B_x \text{ IMF} < 0$, $B_y \text{ IMF} > 0$). Current system DP4 constructed from geomagnetic variations depending from sign of $B_y \text{ IMF}$ explains observed regularities in the cusp and polar geomagnetic variations and dawn-dusk asymmetry in the Polar UVI images. Current system DP3 depending from sign of $B_z \text{ IMF}$ constructed from geomagnetic variations explains regularities in the geomagnetic variations near the noon. It is shown that the polarization of disturbance vectors at different observatories is in agreement with a disturbance passing away from the Sun. Positions of the bow shock, magnetopause during the event are calculated taking into account orbital and rotation movements of the Earth and magnetosphere. The fact of relative low magnetic pressure in the magnetosphere at the position of Interball is not interpreted by changes of dynamical pressure P_d in the solar wind (data from other spacecraft does not allow to conclude this) and following radial movements of magnetopause and bow shock. Other scenario of the studied event is suggested. In this case deformation of the magnetopause is not so large as was reported by the other authors, movements of the magnetopause and bow shock are interpreted by reconnection processes caused by B_y and B_z components of IMF.

Paper Number: Mbp.07*Zvenigorod, Russia, February 8-13, 1999*

**CHARACTERISTICS OF ELECTRONS IN THE PLASMA TRANSIENTS WITHIN LLBL
AS OBSERVED WITH INTERBALL TAIL PROBE**

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It was shown that magnetosheath-like plasma transients in LLBL have characteristic double structure with cooler, denser, and faster leading part compared to the trailing part. They keep this structure while evolving with the distance from magnetopause: convective velocity and number density diminish, and temperature increases with the distance from magnetopause. Observations indicate that many of them are separated from the magnetosheath. They were dubbed Disconnected Magnetosheath Transfer Events [1].

We use the data of ELECTRON in comparison with SCA-1 and magnetic field data to get more information on the structure of DMTEs and on their place in the formation of the LLBL. Due to high velocity of electrons they are good indicator of magnetic field topology. Electrons are also very useful for analysis of plasma boundaries. Observations of electrons seem to confirm two basic results of DMTEs: their double structure and their disconnection from the magnetosheath. Additionally, electrons indicate the sharpness of the boundaries separating DMTEs from the rest of LLBL. Electrons also indicate that DMTEs provide important source of LLBL plasma.

- 1 Vaisberg, O.L., V.N.Smirnov, L.A.Avanov, J.H.Waite,Jr., J.L.Burch, C.T.Russell, A.A.Skalsky, and D.L.Dempsey, Observation of isolated structures in the low latitude boundary layer with Interball Tail Probe. *Geophys.Res.Lett.*, Vol. 25, No. 23, 4305, 1998.

Paper Number: Mbp.08

**MAGNETOSPHERIC PLASMA OF INTERMEDIATE ENERGIES OBSERVATIONS
WITH SCA-1 ON THE INTERBALL TAIL SATELLITE**

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Quasi-isotropic ions of intermediate energies (100-1000 eV) are frequently observed on Interball in the outer magnetosphere. Sometimes these ions are seen as separate steady component. There are cases of intermittent appearance of intermediate energy ions. There are many cases when the traces of this component are seen on the background of more energetic plasma. We give systematic review of 1-year observations discuss the origin of these ions.

Paper Number: Mbp.09

**DYNAMICS OF THE ESCAPE OF ENERGETIC PARTICLES
FROM THE MAGNETOSPHERE:
SIMULTANEOUS INTERBALL AND GEOTAIL OBSERVATIONS**

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Simultaneous observations of the directional intensities of energetic ions and electrons ($E > 30\text{keV}$) were obtained with fine-time resolution by the DOK-2 instrument onboard the INTERBALL spacecraft in the vicinity of the dawn or dusk magnetopause inside the magnetosphere and/or the adjacent magnetosheath and the EPIC instrument of the GEOTAIL spacecraft upstream from the Earth's bow shock. Detailed examination of the IMF and comparison of the energy spectra of the particle directional intensities streaming sunward away from the bow shock with those flowing antisunward along the magnetopause provide direct evidence for the dynamics of the escape process of magnetospheric ions, which constitute the dominant component of the upstream energetic ion population.

Paper Number: Mbp.10

Session V:

Solar Wind

**ION FLUX (PRESSURE) PULSES IN THE SOLAR WIND
OBSERVED FROM THE INTERBALL-1, WIND AND OTHER SPACECRAFT.
PART 1. SOLAR ORIGINS AND INTERPLANETARY FEATURES**

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During the last three years, there have been several observations of sudden, large and short changes in the solar wind dynamic pressure. Some of the changes are due to the passage of CMEs, but others appear to be abrupt crossings into regions of different density. Observations of the changes from more than one spacecraft allow an estimate to be made of their spatial extent and their variation as they travel to Earth. We discuss examples of such changes and their possible reasons.

Paper Number: SW.01

**COMPARATIVE ANALYSIS OF PLASMA AND MAGNETIC FIELD FLUCTUATIONS
IN THE MAGNETOSHEATH AND SOLAR WIND
BY INTERBALL AND WIND DATA**

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R.P. LEPPING

GSFC

The large and fast fluctuations of ion flux and magnetic field in the Earth's magnetosheath were studied for one month measurements in January - February 1997 at the dusk flank of the magnetosphere. These variations were compared between them and with the simultaneous ones in the solar wind. The problem of the mutual correlation of these variations are discussed.

Paper Number: SW.02

**INTERBALL-TAIL AND WIND OBSERVATIONS OF THE ENERGY INPUT
IN THE MAGNETOSPHERE**

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ADAM SZABO AND RON LEPPING
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ALAN LAZARUS AND JOHN STEINBERG
MIT, USA

We compare solar wind measurements conducted by INTERBALL-TAIL and WIND spacecraft upstream of the Earth's bow shock. Energy input to the magnetosphere (Akasofu epsilon parameter) is computed with the use of data from both spacecraft. Various algorithms of this predictive parameter calculation are analyzed for the maximum similarity of prediction from both spacecraft. We also discuss geophysical reliability of the solar wind monitoring for magnetic storms and substorms.

Paper Number: SW.03

**HOT FLOW ANOMALIES AT THE BOW SHOCK AND
FLOW ANOMALIES IN THE MAGNETOSHEATH OBSERVED WITH
INTERBALL TAIL PROBE**

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J.L. BURCH, J.H. WAITE, D.L. DEMPSEY
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Several hot flow anomalies in front of the bow shock were identified in 1996 in the data of fast 3-D ion measurements of the SCA-1 ion spectrometer on the Interball Tail Probe. We use ion and magnetic data to analyze the structure of these HFAs and magnetic conditions favorable for their development. We use also WIND data to tentatively identify interplanetary discontinuities responsible for these HFAs. We report two new findings compared to previous investigations of HFAs with AMPTE and ISEE spacecraft. One distinct double structure of HFAs in the solar wind with trailing (sunward) part being more isotropized. Another is a clear evidence of two ion components within HFA: modified solar wind beam and non-gyrotropic reflected ion beam(s). We present detailed development of interaction of two ion components within HFAs and magnetic structures within these HFAs. A number of very strong flow anomalies within the magnetosheath, including ones quite close to the magnetopause are identified. We present evidence that these flow anomalies, apparently associated with propagation of interplanetary discontinuities through the magnetosheath, lead to the development of wave motions of the magnetopause.

Paper Number: SW.04

**THE INTERNAL STRUCTURE OF HOT FLOW ANOMALIES
OBSERVED UPSTREAM THE EARTH'S BOW SHOCK**

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Magnetic field and plasma measurements carried out by spacecraft in the upstream region of the Earth's bow shock reveal the existence of the interesting phenomenon called HFA (Hot Flow Anomaly). These events are associated with the appearance of hot plasmas deflected from the solar wind direction and large-amplitude variations of the magnetic field. The hot flow anomalies are typically detected when the a tangential or rotational discontinuity pass through the spacecraft location upstream the Earth's bow shock. The present paper is focused on the internal structure of the HFA and the origin of rotational waves observed inside the region of hot plasma and shock-like transitions at leading and trailing edges of HFA.

Paper Number: SW.05

**ENERGY TRANSFER FROM SOLAR WIND TO MAGNETOSPHERE
BY FIELD-ALIGNED CURRENT**

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Ways for energy transfer from solar wind in the Earth's magnetosphere are studied. The Region 1 field-aligned currents directly transport the energy and momentum of the solar wind plasma to the Earth's magnetosphere, ionosphere and upper atmosphere. The magnetospheric plasma sheet convection generated by solar wind is another source for plasma sheet particle and cold ionospheric polar wind ions acceleration. This energy transfer way includes the tail lobe magnetic field energy storage connected with the increasing of the tail current during southward IMF. The model calculations of the field-aligned currents contribution to magnetospheric field demonstrate a condition for substorm break up.

Paper Number: SW.06

SEMI-EMPIRICAL MHD MODEL OF THE PLANETARY BOW SHOCKS**M. VERIGIN***Space Research Institute of RAS, Moscow, 117810, Russia*

An analytical semi-empirical bow shock model applicable for a wide range of the sonic Mach numbers ($1 < M_s < \infty$ in hydrodynamic approximation) is being generalized for the case of non field aligned MHD flows. Bow shock positions and shapes are presented as a function of Ma Alfvénic and M_s sonic Mach numbers, and of the angle between the subsolar shock normal and the upstream magnetic field. The model is based on the MHD Rankine-Hugoniot relations deduced for the curved shock and is verified by comparison with the results of 3-D MHD calculations. Model can be applied for the studies of variety of physical processes operating in the vicinity of different planets that are influenced by bow shocks, e.g., electron and ion foreshock formation and plasma wave generation by specularly and diffusely reflected ions; the investigation of mechanisms of the solar wind deceleration in the shock foot and shock itself; the studies of the plasma wave propagation along shock surfaces; analysis of the processes of shock overshoot formation and plasma turbulence generation inside the magnetosheath; investigation of micropulsations generated at the magnetopause, etc.

Paper Number: SW.07

**ION FLUX (PRESSURE) PULSES IN THE SOLAR WIND
OBSERVED FROM THE INTERBALL-1, WIND AND OTHER SPACECRAFT.
PART 2. MAGNETOSHEATH PASSES AND GEOMAGNETIC SEQUENCES****P.A. DALIN, G.N. ZASTENKER***Space Research Institute of RAS, Moscow, 117810, Russia***A.J. LAZARUS***Center for Space Research, MIT, Cambridge, USA***A.N. ZAITSEV, V.I. ODINTSOV***IZMIRAN, Troitsk, Moscow region, Russia***D.G. SIBECK***APL JHU, Laurel, USA*

Some effects of sudden, large and short changes in the solar wind dynamic pressure on magnetosphere are studied. The first topic is the comparison of the multi-spacecraft simultaneous observations in the solar wind (by WIND), in the magnetosheath (by INTERBALL-1) and inside the magnetosphere (by GOES-7/9). The second one is the comparison with ground-based measurements of magnetic field. We discuss examples of such events and their role in Sun-Earth connection.

Paper Number: SW.08

THE ROLE OF NONLINEAR INTERACTION IN THE FORMATION OF
LF WHISTLER TURBULENCE
UPSTREAM OF A QUASIPERPENDICULAR SHOCK

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The role of nonlinear interaction in developed low frequency turbulence has been experimentally studied upstream of the ramp of a quasiperpendicular shock. The study has been carried out by application of the methods of bispectral analysis and wavelet decomposition to the AMPTE and INTERBALL Tail Probe magnetic field data. It is shown that three-wave processes play a key role in the formation of the spectrum of the turbulence. Experimental results presented and previous theoretical considerations lead to the conclusion that energy is transferred from a narrow maximum frequency pumped by nonlinear dynamic processes at the shock front into lower and higher frequencies.

Paper Number: SW.09

Special Evening Session:

New Projects

**CLOSELY-SPACED MULTI-SATELLITE ROY PROJECT
TO STUDY MAGNETIC FIELD ANNIHILATION AND STRONG TURBULENCE
AT SMALL SCALES IN CRITICAL MAGNETOSPHERIC REGIONS**

**YU. GALPERIN, L. ZELENYI, S. SAVIN, R. KOVRAZHKIN, M. VESELOV, M. MOGILEVSKY,
A. PETRUKOVICH, V. STEPANOV, M. YANOVSKY**

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E. SOSNOVETS

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Magnetic field annihilation, sometimes called reconnection, is an important phenomenon in natural and astrophysical plasmas which involves energy transformation and strong turbulence phenomena in a wide range of scales. The near-Earth space provides an opportunity to study this phenomenon in situ.

The ROY Project (now in phase A) is aimed to study previously unexplored small-scale phenomena within the so called "diffusion region" where strong plasma turbulence, and magnetic "reconnection" occur in the critical magnetospheric domains. At the dayside these are mainly outer cusps and subsolar magnetopause, but recent findings from INTERBALL Project show that flanks of the magnetosphere can also be sites of these active plasma processes leading to larger scale bulk flows and particle acceleration. On the nightside the most interesting regions are at the earthward edge of the cross-tail current, but their locations are variable. To study these phenomena multi-point measurements are essential at scales from electron inertial length to several ion Larmor radii. The main aim of these measurements is to determine spatial scales of the strong plasma turbulence, characteristic amplitudes and velocities of plasma and magnetic field inhomogeneities, their spectra, accompanying waves and particles characteristics. The project includes a family of satellites consisting of a main (BASE) satellite and 4 subsatellites at distances 10-300 (1000) km. The BASE satellite is with directed antenna for telemetry, and large onboard memory (~10 Gbytes) for the data storage from all the s/c, and its partial onboard treatment, selection of interesting features, compression and transmission to the Earth of only selected high data rate measurements at most interesting intervals. The subsatellites (not more than 100 kg each) with thrusters to control their distance from the BASE will perform in situ plasma measurements and also receive coherent MF radiowaves emitted from the BASE to provide the data for a crude tomography of the rarefied space plasma at small scales. Optional model payloads will be presented. We solicit proposals of our foreign colleagues for mission design, scientific payload and subsatellite construction. Optimistic estimates show that the Project might be accomplished in the first half of the next decade.

Paper Number: NewP.01

POSSIBILITY OF RADITOMOGRAPHIC INVESTIGATION
OF SMALL-SCALE TURBULENCE IN MAGNETOSPHERIC PLASMA

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A new approach to experimental research in space plasmas by a constellation of spacecraft is proposed. Our estimates showed that under conditions of the magnetosphere a phase-difference ray tomography method could be applied in order to reconstruct electron density distribution. The most interesting regions for investigation include plasmashet, polar cusps and some regions in the vicinity of the magnetopause. The orbits for all satellites were chosen in order for them to spend most of the time in the regions mentioned above. The most effective scheme for relative positioning of satellites was selected so as to use bulk motion of plasma itself in respect to the quasi stationary satellites. We say "quasi-stationary" because the velocities of satellites are estimated as 1 km/s while the bulk velocities of plasmoids are usually in the range between 10 and 200 km/s. The spatial resolution of the method is limited by the first Fresnel zone radius which in our case with typical distance between satellites $L \sim 200$ km and frequency of probing radiowave $f \sim 100$ kHz is approximately 20 km. This shows that we will be able to recognize all spatial irregularities predicted by up-to-date theoretical and experimental estimates. The most important advantage of this method in comparison to one-satellite local measurements is that it allows us to see plasma structures not just along the magnetic field line, on which the spacecraft is located, but in the area limited by the satellites which can be a stripe of approximately 200 km x 500 km. Another important advantage of this technique is that it helps to eliminate the influence of the spacecraft on plasma and the measurement carried out onboard.

A big number of reconstructions of electron density distribution was made using different cross-sections of a three-dimensional numerical model of developing plasma turbulence provided by group of Dr. J. Büchner. Analysis of reconstructions showed that this method could give reliable information about the structure of the turbulent regions. In most cases typical scales and shapes of plasmoids were easily reconstructed.

Paper Number: NewP.02

THE MICRO-SATELLITE DEMETER**MICHEL PARROT***LPCE/CNRS, 3A Avenue de la Recherche, 45071 Orleans cedex 2, France*

The micro-satellite DEMETER (Detection of Electro-Magnetic Emissions Transmitted from Earthquake Regions) is a low-altitude satellite (< 800 km) with a nearly polar orbit to be launched by CNES in 2001. The scientific objectives of this project are related to the investigation of the ionospheric perturbations due to the seismic activity, and to the global study of the Earth electromagnetic environment. The payload of DEMETER is composed of several sensors associated to a data processing unit and a large memory in order to record the information all around the Earth independently from a telemetry station.

DEMETER will measure electromagnetic waves from DC up to 4 MHz, and plasma parameters. There are two modes: i) a survey mode to record low bit rate data all around the Earth, and ii) a burst mode to record high bit rate data above main seismic regions. The duration of the mission is two years. This paper will describe in details the scientific objectives of the project, the payload, the operations, and the relations with other experiments. It is expected to have collaboration with ground-based experiments performing measurements of DC fields, electromagnetic noise in various frequency bands, ionospheric parameters, optical parameters,...

Paper Number: NewP.03

PROJECT RESONANCE: ACTIVE MAGNETOSPHERIC STUDY**L. ZELENYI, M. MOGILEVSKY, YU. GALPERIN***Space Research Institute of RAS, Moscow, 117810, Russia***V. TRAKHTENGERTS, A. DEMEKHOV***IAP RAN, N.Novgorod, Russia***A. ARYKOV, E. TITOVA, A. YAHNIN***PGI KB RAN, Apatity, Russia*

We present the initial information on a new magnetospheric study project.

Project main goals:

- An artificial influence on the operation of magnetospheric maser; Study of the possibility to control the processes inside the Earth's magnetosphere; Long-term observations of the processes localized in a selected flux tube.

Basic options:

- Artificial excitation and/or stimulation of wave modes; Modification of the flux of precipitating particles; Local modulation of thermal plasma parameters (density, temperature, etc.); Formation of the region with increased reflection index in the ionospheric footpoint of a selected magnetic flux tube.

Project features:

measurements on the magnetosynchronous orbit; artificial positive (negative) feedback applied to the natural oscillatory system.

Paper Number: NewP.04

**OPTIMIZATION OF THE PARAMETERS OF ORBITS OF A SPACECRAFT
FOR CARRYING OUT RESEARCH OF THE EARTH'S MAGNETOSPHERE**

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The problem of choosing the parameters of orbits of a spacecraft which can provide finding the spacecraft staying in the chosen beforehand power tube for rather a long time is under consideration.

The results of the investigations both for an ideal situation (without restrictions) and for situations which take into account the existing restrictions for the possible meanings of the parameters of the orbits, connected with the real booster and cosmodromes for their landing are given.

Paper Number: NewP.05

THE THREE LEVELS EXPERIMENT

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A.A.PETRUKOVICH, V.I.PROKHORENKO, V.G.RODIN, S.A.ROMANOV, V.S.ROMANOV,
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The INTERBALL Project is the part of the International Project INTMINS INTERball-Mir-INSpire). For INTMINS, plasma and electron beams are injected from the space station MIR into the surrounding plasma. The plasma-wave phenomena resulting from the injection are observed with SPRUT-VI experiment and Zond-Zaryad instrument flown onboard the MIR. The simultaneous ground-based observations of waves caused by electron and plasma injections are carried out by the INSPIRE network (Interactive NASA Space Physics Ionosphere Radio Experiments). During the first phase of the INTMINS Project (1995-1998) electron and plasma injections were performed when MIR was above the sites of the INSPIRE network. The second phase start on October, 1998 after the delivery of SPRUT-VI onboard MIR. The third phase have made in 1999-2000 when MIR and INTERBALL were on the same magnetic field line. The major objectives was to work out the most efficient way of the collaboration between all participants of the INTMINS project. The current plan for INTMINS is to have two major operations periods per year in November and April. The first observations from SPRUT-VI and Zond-Zaryad, the result of INSPIRE network observations during major operations periods, and results of theoretical calculations of the propagation of electromagnetic waves connected with electron beam injection will be presented.

Paper Number: NewP.06

DISCUSSION ABOUT RKA PROJECTS

N. SANKO

Russian Space Agency (RKA), Moscow, Russia

Paper Number: NewP.07

Session VI:

Auroral Particles and Waves

THE LOCATION OF THE AURORAL ACCELERATION REGION

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The orbit of the FAST satellite, which had an initial apogee of ~ 4170 km, was selected in order to investigate the bottom of the auroral acceleration region. Based on previous results from the S3-3 satellite it was thought that encounters with the auroral acceleration region would occur only rarely. In fact, however, FAST data has shown that there is a very strong seasonal dependence in the altitude of the auroral acceleration such that in winter at apogee FAST encounters the auroral acceleration region on most orbits. We are making a statistical study of the upwardly accelerated ion beams which indicate the regions of upward parallel electric field responsible for the acceleration of inverted-V electrons and the creation of the discrete aurora. So far FAST has measured several thousand upwardly accelerated ion beams. The highest beams extend to energy above 20 keV. The lowest altitude ion beam has been found at 1270 km altitude. In some cases most of the parallel acceleration region is below the apogee of FAST. The majority of the larger ion beams are found in the premidnight sector in agreement with previous studies of the distribution of inverted V electrons. The most energetic ion beams indicate that the average parallel electric fields are at least 10 mV/m in at least some cases in the auroral acceleration region.

Paper Number: A.01

OBSERVATIONS OF WIDE BAND BURSTS OF AURORAL KILOMETRIC RADIATION WITH POLRAD

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Sometimes the auroral kilometric radiation is observed with POLRAD in the form of wide band bursts, characteristic for their sudden onsets lasting for about 1 minute over frequency range from 30 to 900 kHz, and decays of the order of 10 minutes. They are associated with onsets of auroral structures as seen from Polar UV Imager. They are also associated with field aligned currents and wave turbulence - particle events, recorded on Interball-2, when the spacecraft is passing through the evening sector of MLT. Simultaneous observations of the wide band AKR bursts and sudden brightenings of auroral structures indicate that large segments of the auroral altitudes, from the ionosphere up to 20000 km, can become active in a very short time. This may suggest that primary disturbances responsible for the activation are propagated as inertial Alfvénic waves. Parallel electric fields, characteristic for these waves, can be presumably capable to accelerate electrons to energies sufficient for generation of the AKR (1 - 10 keV).

Paper Number: A.02

AURORAL PARTICLES AND SOLITARY WAVES OBSERVED BY THE FAST SATELLITE**J.P. MCFADDEN, C.W. CARLSON, R.E. ERGUN***Space Sciences Lab, University of California, Berkeley*

The FAST satellite was designed to investigate the micro-scale structure of the auroral acceleration region. Two new results from FAST are the identification of electron hole solitary waves associated with field aligned electron beams and the re-characterization of ion hole solitary waves associated with upgoing ion beams. The electron hole solitary waves are observed primarily in the downward current regions. In these regions, ionospheric electrons are often accelerated to several keV by parallel electric fields as determined by comparisons of the potentials inferred from the electric fields and from the electrons. Instabilities in the electron beam lead to the formation of a turbulent plasma with rapidly varying electron fluxes, electron hole solitary structures, and rapid ion heating. Characteristics of the plasma and properties of the electron holes will be presented. Ion hole solitary waves were first identified by the S3-3 satellite and later characterized by Viking observations. Reports using Viking measurements indicated slowly (10-25 km/s) moving solitary waves with potentials typically ~ 1 Volt, having lengths of ~ 100 meters, and propagating in a plasma containing a cold dense background. In contrast to the Viking data, FAST measures little or no cold plasma in the density cavities associated with ion beams and ion hole solitary waves. Debye lengths are thus typically > 200 meters. Potentials associated with ion hole solitary waves can produce measurable shifts in the inverted-V electron's spectral peak. From the measured potentials which can exceed 100 Volts, the ion hole solitary waves are determined to be moving at 100-1000 km/s, and have scale sizes of ~ 1 km (~ 8 Debye lengths). Differences between the FAST and Viking observations will be discussed:

Paper Number: A.03

**WAVE NORMAL DIRECTIONS OF AKR EMISSION
OBSERVED ONBOARD THE INTERBALL-2 SATELLITE****M. PARROT, F. LEFEUVRE, J.L. RAUCH***LPCE/CNRS, 3A Avenue de la Recherche, 45071 Orleans cedex 2, France***M. MOGILEVSKY***Space Research Institute of RAS, Moscow, 117810, Russia***O. SANTOLÍK***KEVF-MFF, Charles University, Praha, Czech Republic*

The MEMO experiment is a part of the INTERBALL 2 wave consortium. It is connected to a total of six electric and nine magnetic independent sensors. It provides waveforms associated with the measurement of two to five components in the three frequency bands: ELF (5-1000 Hz), VLF (1-20 kHz), LF (20-250 kHz). Waveforms of three magnetic components and one electric component recorded during observations of AKR allow a detailed study of the characteristics of these emissions. In particular the wave normal directions of AKR relatively to the Earth's magnetic field is determined using several methods: - the classical methods based on the plane wave approximation (Means and McPherron) and, - the WDF (Wave Distribution Function) method which represents the evaluation of the wave energy density distribution with respect to the angular frequency and the wave normal direction(s). Several cases will be presented in this paper.

Paper Number: A.04

THE OBSERVATIONS OF THE SUBAURORAL NONTHERMAL RADIO EMISSION OF TERRESTRIAL MAGNETOSPHERE ONBOARD THE INTERBALL-1 SATELLITE.**V.N. KURIL'CHIK***Sternberg Astronomical Institute, Moscow State University 119899, Moscow, Russia***H.O. RUCKER, M.Y. BOUDJADA***Space Research Institute, A-8010 Graz, Austria*

The results of the observation of subauroral nonthermal radio emission (SANE) for 3 years of the satellite INTERBALL-1 operation are presented. This high-frequency narrow-band radio emission from the inner terrestrial magnetosphere was discovered in 1992 on board the satellite Prognoz-10 at 1486 kHz. The AKR-X experiment on board the INTERBALL-1 satellite gave about 300 registrations of SANE events at the frequency of 1463 kHz, predominantly in the Northern hemisphere where the orbits of the satellite are localized.

SANE is observed at the night-side sector of the terrestrial magnetosphere with a pronounced maximum at its morning (0-5 hours MLT) part. Two maxima of the occurrence of SANE in universal time (UT) are discovered. The first one is a result of excitation of the Northern subauroral source of emission directly when this region is immersed in the magnetospheric tail (in its plasmasheet). The second maximum is apparently a result of excitation of the subpolar region in the Southern hemisphere, when part of energy in form of energetic electrons (sometimes in form of SANE transmitted into "electronic split" between the radiation belts) is transferred to the north subpolar region. Enhanced geomagnetic activity stimulates convection of energetic particles into the subauroral regions from the plasmasheet and excitation of the SANE.

A brief consideration of the main peculiarities of the SANE and nature of the source of emission is presented.

Paper Number: A.05

**INTERBALL-2 OBSERVATIONS OF PARTICLE BURSTS
ABOVE THE NIGHTSIDE NORTHERN POLAR CAP****V.A. STEPANOV, A.A. PETRUKOVICH, YU.I. GALPERIN***Space Research Institute of RAS, Moscow, 117810, Russia***J.-A. SAUVAUD***Centre d'Etude Spatiale des Rayonnements, Toulouse, France*

A statistical survey of particle burst observations by the Interball-2 at high invariant latitudes (up to 81 degrees) above the nightside Northern polar cap is presented. For a period of October-November 1996, we collected a data set of 228 such particle bursts. A comparison of the data set with IMF and solar wind parameters leads to the following conclusions: 1) high latitude particle bursts were observed on 30% of Interball-2 passes above the nightside polar cap (when particle data were available); 2) occurrence probability of the bursts does not depend strongly on global magnetic activity conditions and solar wind parameters.

Composition of the bursts and observed plasma parameters are in many cases similar to those in the plasma sheet. We present a detailed description of several cases, to illustrate possible plasma sheet origin of the observed particle bursts.

Paper Number: A.06

ELECTROMAGNETIC TURBULENCE NEAR THE POLAR BOUNDARY OF THE AURORAL REGION: INTERBALL-2 MEASUREMENTS

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Observation of electrostatic and electromagnetic waves in the DC - 1 MHz frequency range were carried out onboard INTERBALL-2 satellite as well as suprathermal ions and electrons fluxes and DC magnetic field. Strong spikes of electromagnetic (SE) emissions with the broad band spectrum (up to 10 kHz) were detected near polar boundary of the auroral region simultaneously with registration of geomagnetic field perturbations. The occurrence of SE waves peaks in the pre- and midnight sectors (20.00 - 02.00 MLT) is accompanied by narrow band HF emissions with a sharp low-frequency cutoff above local electron gyrofrequency. The common analysis of suprathermal particles and waves distributions shows that SE is associated with downflowing electrons with an inhomogeneous distribution function and upflowing ion fluxes of 0.1 - 1 keV energy. Three typical scale of SE were detected: 100-400 km, 30-60 km and 0.1-1km which connected with a electron flux variation region, stratification of electron flux and dimension of electromagnetic structures respectively. Properties of these waves are presented and possible hypotheses of their origin are discussed.

Paper Number: A.07

MAGION 5 VLF-PHENOMENA OBSERVATIONS

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The scientific payload of MAGION 5 includes VLF-ELF broadband wave measurements of the electric and magnetic field components, using a double-probe dipole 1.7 m long and search-coil sensors.

Regular broadband wave observations started in May 1998 after reactivation of MAGION 5. The recorded data cover altitudes above 1 R_E from the equator plane to the auroral region. The variety of phenomena observed is large, the records include all the known LHR phenomena observed in the plasmasphere, e.g., like LHR whistlers, LHR noise bands and magnetically reflected whistlers (MRW). Such observations allow to continue a study of MRW observed the first time onboard the OGO 1 [Smith and Angerami 1968] and observed as well by MAGION 4 in the range of $1.5 < L < 3$ close to the equatorial region. A review of different types of the recorded VLF-Phenomena will be presented and a possible relation between some of them will be discussed.

Paper Number: A.08

**VLF WAVES OBSERVED BY BOTH THE MEMO AND NVK EXPERIMENTS:
INTERBALL-2 MEASUREMENT**

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The VLF waves detected in the auroral zone exhibit various spectral features. The identification of the spectral and propagation characteristics can give a diagnostic of the auroral plasma and point out the interaction processes between waves and particles. Both the MEMO and NVK ONCH experiments onboard the auroral probe INTERBALL-2 perform simultaneous VLF waves measurements in the frequency range from 10 Hz to 20 kHz. Analogic NVK ONCH data are continuously recorded for two components: one electric component E_Y and one magnetic component B_X . These data are sampled at frequency of 48 kHz on ground. While, the MEMO experiment is able to snap up several time intervals with the full waveform of the three magnetic components and two electric components. This functioning mode allow to obtain a very good frequency resolution and to determine the full propagation characteristics of waves, in particular: the wave normal direction, the polarization and the ellipticity. In this presentation, we show several examples of VLF hiss observed in the auroral region. A full determination of the propagation characteristic is given and an interprétation of the spectral features is proposed.

Paper Number: A.09

MEASUREMENTS OF AKR POLARIZATION PARAMETERS WITH POLRAD**J. HANASZ, M. MALYCHA***Space Research Centre, Torun, Poland***M.Y. BOUDJADA, H.O. RUCKER***Space Research Institute, Graz, Austria***R. SCHREIBER***N. Copernicus Astronomical Centre, Torun, Poland***Z. KRAWCZYK***Institute of Aviation, Warsaw, Poland***M.M. MOGILEVSKY***Space Research Institute of RAS, Moscow, 117810, Russia*

POLRAD is connected to a system of 5 antennae (2 dipoles and 1 monopole) aimed to measure the Stokes parameters of wave polarization within the frequency range from 4 kHz to 1 MHz. We show examples of polarization spectra of the auroral kilometric radiation (AKR). The case of the left handed (LH) polarization of AKR at higher frequencies simultaneous with the right handed (RH) polarization at lower frequencies, of roughly equal intensities, was met. This happened when the s/c was orbiting through the dayside northern magnetosphere. This observation may suggest that intensity of the left handed ordinary (L-O) mode can reach intensity of the right handed extra-ordinary (R-X) mode. The polarization was mostly circular since little linear component was measured. The AKR was not totally polarized (polarization degree was from -70% to +60%). In another time interval the strong LH polarized AKR was observed from the s/c orbiting in the dayside part of the northern hemisphere. At the time of writing this abstract we have not known the attitude of the s/c. If the source was located in the nightside northern magnetosphere then the observed LH polarization would correspond to the dominating L-O propagation mode, while for the dayside northern source the dominating mode would be R-X.

Paper Number: A.10

**AURORAL KILOMETRIC RADIATION AND GEOMAGNETIC ACTIVITY:
INTERBALL-2 MEASUREMENTS****T.V. ROMANTSOVA, M.M. MOGILEVSKY***Space Research Institute of RAS, Moscow, 117810, Russia***J. HANASZ***SRC, Torun, Poland*

It is well known that Auroral Kilometric Radiation (AKR) is well correlated with geomagnetic activity and even might be used as an index of it. We present the results of comparative analysis of AKR intensity, measured onboard the INTERBALL-2 (Auroral Probe) satellite, and magnetic field measurements made by ground based networks IMAGE and CANOPUS. It was found that typical correlation distance between satellite position and ground station, depends a longitudinal source dimension and its altitude. Using a simple geometry of AKR propagation and frequency characteristics the position of the localized source as well as its displacement have been determined.

Work was supported (in part (1)) by grants INTAS 94-1695 and 96-2346.

Paper Number: A.11

SMALL-SCALE ELECTROSTATIC INHOMOGENEITIES IN THE
POLAR CAP AND AURORAL REGION: INTERBALL-2 MEASUREMENTS

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In this presentation some results of the analysis of electromagnetic and electrostatic signals in the VLF frequency range measured at the INTERBALL-2 satellite are discussed. We investigate the waveform of the signals with the time resolution 20kHz. Two types of electrostatic emissions spikes (ESS) near the electron plasma frequency were observed. The first type of emission with a typical duration of about 10 msec was detected near the polar boundary of the Auroral region. The second one has typical time scale of a few seconds and was observed in the night sector of the Polar Cap. The detailed analysis of the second type about ESS shows a strong modulation of the frequency at few hundred Hz. Possible hypotheses of ESS nature are discussed: the second type of ESS can be produced at the boundary of plasma clouds drifting from the Tail region of the magnetosphere to Auroral zone.

Paper Number: A.12

DYNAMICS OF AURORAL ELECTRON ACCELERATION REGION
AS REVEALED BY AURORAL HISS

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The Interball-2 satellite auroral hiss observations performed during November-December 1996 were compared with simultaneous observations of auroras. Interball-2 had the apogee above the Northern Hemisphere at high latitudes at geocentric distance 2.5-4 Re. In the considered events the satellite crossed the auroral zone in the evening sector, went to the polar cap, and again crossed the auroral zone in the post-midnight sector. Auroral data were obtained from the ground-based observations in Loparskaya and Lovozero (Kola peninsula, north-west of Russia) and in Longyearbyen, Svalbard. Auroral dynamics was used as indicator of the temporal and spatial behavior of the acceleration region. Main attention is paid to strong variations of auroral hiss intensity and frequency at latitudes poleward of the auroral oval, and their relation to auroral dynamics. The temporal intensifications of the hiss, which were observed well poleward from the auroral oval, correlate with both substorm onset and week intensification of a single aurora arc. The auroral hiss cutoff frequency likely depends on distance between auroras and satellite. The cutoff frequency of auroral hiss decreases when the distance between satellite footprint and auroras decreases and vice versa. Thus the variations of intensity and cutoff frequency of auroral hiss observed by the satellite poleward of auroral oval are close related with both temporal and spatial dynamics of auroral electron acceleration region. Behavior of cutoff frequency can be explained by propagation in the whistler mode at wave normal angles near the resonance cone from a spatially localized moving source. Applicability of auroral hiss characteristics for diagnostic of acceleration region is discussed.

Paper Number: A.13

Zvenigorod, Russia, February 8-13, 1999

A STUDY OF PROPAGATION OF AKR IN A HOT PLASMA**O. SANTOLÍK***KEVF-MFF, Charles University, Praha, Czech Republic***M. PARROT, F. LEFEUVRE, J.L. RAUCH***LPCE/CNRS, Orleans, France***M. MOGILEVSKY***Space Research Institute of RAS, Moscow, 117810, Russia***J.-A. SAUVAUD***CESR/CNRS, Toulouse, France*

On January, 28, 1997, the INTERBALL 2 satellite observed a highly structured emission of auroral kilometric radiation. The lower frequency limit of this emission is by a factor of 1.3 higher than the local electron gyrofrequency. At the same time the plasma instruments observed a majority of plasma at energies of several keV. We investigate the influence of the hot plasma medium on the wave propagation. Different wave propagation parameters are calculated and compared with the cold plasma model. We analyze multicomponent waveform data obtained by the MEMO experiment and we estimate the wave distribution functions of AKR for different plasma models. The results are compared with the calculations based on the cold plasma approximation.

Paper Number: A.14

**DIFFERENT REGIMES OF CHARGED PARTICLE ACCELERATION
BY ELECTROSTATIC TURBULENCE IN THE
AURORAL MAGNETOSPHERE****P.A. BESPALOV***Institute of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, 603600, Russia*

Magnetic field-aligned electric currents are typical for the auroral magnetosphere. In our opinion, the regions with field-aligned current can be responsible for effective charged particle acceleration in the high-latitude magnetosphere for stationary and nonstationary conditions, especially if a plasma turbulence exists. In this work, we analyze the acceleration processes. Accelerations of charged particles by a quasistatic electric field, by weak or strong plasma turbulence are taken into account. Solutions of stationary kinetic equation are found for acceleration by weak and strong plasma turbulence in an inhomogeneous magnetic field for different correlations between system time and space scales. The estimate of energy input shows the efficiency of the acceleration mechanism in such processes in the chosen parts of the energetic spectrum. This model contributes to understanding both the flux distribution of energetic particle at high latitudes and the global energy budget of the auroral magnetosphere.

Paper Number: A.15

AVERAGE AURORAL ELECTRON ENERGY DERIVED FROM OPTICAL SPECTRA IS DIFFERENT FOR STATIONARY AND NON-STATIONARY SOLAR WIND**T.A.HVIUZOVA, S.V.LEONTIJEV***Polar Geophysical Institute, Murmansk, Russia*

Optical spectra of auroras from discrete auroral oval were regularly taken at Loparskaya station ($L \sim 5.5$) at zenith during 1970-1984. Values of intensity ratio of red-to-green lines ($R = I(630.0)/I(557.7)$) were measured and grouped according to different characteristics of the solar wind. An unexpected result is that average values of $R \sim 0.4$ were obtained for streams from coronal holes, while $R \sim 0.8$ for non-stationary solar wind streams related to solar flares. This means a significantly lower average electron energy in auroras for the latter cases. Large-scale red aurora of type A (strongly enhanced red line) was never observed during solar streams from coronal holes. Conversely, during flare-related non-stationary solar wind streams values $R \geq 1$ were often observed. The evaluation of average electron energy from R values is straightforward only for a definite form of electron energy spectrum. However, during flare-related streams auroral electron distributions are sometime rather wide ("broadband") and this evaluation is ambiguous. But the systematic appearance of large amount of low-energy electrons (< 1 keV) during non-stationary solar wind streams (as compared to typical auroral electron distributions) may be stated with certainty.

Paper Number: A.16

**FORMATION OF NONLINEAR ELECTROSTATIC WAVES
AND LOCALIZED MOVING STRUCTURES IN AURORAL MAGNETOSPHERE:
PLASMA CONDITIONS AND EXPECTED WAVEFORMS IN THE
INTERBALL MEASUREMENTS****A.V. VOLCSEVICH***Mogilev Pedagogical University, Mogilev, 212026, Belarus Republic***YU.I. GALPERIN***Space Research Institute of RAS, Moscow, 117810, Russia*

Plasma conditions and scenarios are studied analytically and numerically for formation of various nonlinear electrostatic waves and moving structures of the ion-sound type in the auroral magnetosphere. For this end, an analytical study is performed of several factors which can have a role in the formation of 2D and 3D electrostatic structures. The following factors are considered: polarization drift of electrons and ions, electron collisions (Coulomb or effective), modification of the background plasma by intensive quasi-stationary waves, large scale electric field, and presence of several particle populations (multicomponent plasma). For some selected particular conditions scenarios are suggested and modeled for formation of 2D and 3D electrostatic structures. The waveforms derived are intended for comparisons with direct measurements from INTERBALL and other satellites.

Paper Number: A.17

Session VII:

Plasma Sheet Dynamics and Turbulence

PLASMA-SHEET FLOW TURBULENCE: OBSERVATIONS AND ANALYSIS

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The plasma flow velocity and the magnetic field were measured with high time resolution by the ISEE-2 satellites in the Earth's plasma sheet. On timescales of a minute or less, the plasma flows appear to be turbulent and the magnetic field appears to be disordered. The measurements are examined statistically and turbulence quantities such as correlation times, correlation lengths, and Fourier spectral shapes are obtained. It is argued that the turbulence is dominated by eddies rather than Alfvén waves. The statistical analysis of the flow measurements are used to construct an eddy-diffusion coefficient. An analysis of meso-scale flow in the plasma sheet coupled to the ionosphere leads to viscoelastic-fluid picture for the plasma sheet. Some predictions about the turbulent flows in the plasma sheet are made utilizing this picture.

Paper Number: Turb.01

**PLASMA VELOCITY AND MAGNETIC FIELD OSCILLATIONS
IN THE DISTANT PLASMA SHEET**

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Measurements of the magnetic field and low energy plasma by the GEOTAIL spacecraft were utilized to study correspondence between the plasma velocity and magnetic oscillations in the distant plasma sheet at $X = -(79-200) R_E$. A total of 14 extremely quiet days from available GEOTAIL data in 1993-1994 (12-s averages of the magnetic field and plasma parameters) were chosen for the analysis, identification of the plasma sheet and estimation of the magnetic activity being realized according to Troshichev et al. [JGR, in press]. Case study of behavior of magnetic field and plasma velocity shows that correspondence between the changes in these parameters is not often carried out. The Fourier analysis also shows sometimes striking discrepancy in the frequent spectra for magnetic and plasma parameters when powerful oscillations of plasma velocity (usually V_Y or/and V_Z components) in range 3-8 min occurs against the almost calm magnetic field and vice versa. The applicability of the MHD approach in the distant plasma sheet is discussed.

Paper Number: Turb.02

MAGNETIC FIELD AND ENERGETIC PARTICLE FLUX FLUCTUATIONS IN THE DISTURBED PLASMA SHEET

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Mechanisms of the energy conversion in the earth magnetotail remain unclear and are widely debated. Enhanced low-frequency fluctuations are detected in the tail during active periods. Whether these fluctuations are just local background noise or are a part of self-consistent global magnetotail dynamics is unknown but should be manifested in properties of fluctuations. We present several examples of the recent INTERBALL-TAIL measurements in the magnetotail and first results of the statistical analysis. This work is supported by INTAS grant 97-1612.

Paper Number: Turb.03

MEDIUM SCALE MAGNETOSPHERIC TURBULENCE AND ITS ROLE IN PLASMA SHEET STABILITY

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The theoretical part of INTERBALL project includes the analysis of the main properties of the medium scale magnetospheric turbulence and the determination of its role in the stability of existing large scale magnetospheric structures. Auroral and plasma sheet observations revealed the existence of electrostatic turbulent vortexes of different scales. The transport of particles produced by such electrostatic structures can be more than an order of magnitude larger than the transport produced by large-scale magnetospheric convection which require the reanalyzing of magnetospheric convection picture. The developed theoretical approach give the possibility to introduce the turbulent particle transport in the solution of the problem of plasma sheet dynamics and stability. The program of the verification of the theory predictions on the base of INTERBALL measurements is discussed.

Paper Number: Turb.04

PROBLEMS OF PLASMA SHEET STUDY

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We describe several problems of investigations of the plasma sheet structure at various scales: (1) statistical studies of global distributions of average parameters and their dependences on the interplanetary conditions; (2) multi-point case study of phenomena of the medium scale including plasmoids, convection jets, bursty bulk flows; (3) investigations of micro-physical processes in the plasma sheet with developed plasma turbulence under different interplanetary conditions and dawn-dusk potential drop using two-point and auto-correlation function technique. These problems can be studied using multi-point observations of ISTP spacecraft. Several preliminary results are presented and plan of future investigations will be suggested.

Paper Number: Turb.05

LOW FREQUENCY ELECTROSTATIC WAVES
GENERATED BY NONGYROTROPIC ION DISTRIBUTIONS

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The stability of non-isotropic ion distributions with velocity space holes of the peculiar type expected in the vicinity of the magnetic field reversal region is investigated. It is shown that such distributions may be unstable to electrostatic wave excitation. The growth rate and the direction of wave vector of the excited waves are strongly dependent on ion hole parameters and electron and ion temperatures. The solution of the quasi-linear equation for waves excited in the normal direction to the current sheet is found. The wave energy is obtained as a function of the ion hole parameters.

Paper Number: Turb.06

A FIRST LOOK ON A Pc1 EVENT
OBSERVED SIMULTANEOUSLY AT INTERBALL-2 AND ON THE GROUND

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An first orientating survey on existing data concerning a Pc1 event observed simultaneously onboard Interball-2 and on the ground in northern Scandinavia

Paper Number: Turb.07

Session VIII:

Thermal Plasma at High Latitudes

SOME RESULTS AND PROBLEMS OF THE INTERBALL DATA COMPARISONS WITH THEORIES OF MAGNETOSPHERIC AND AURORAL PLASMAS

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A very significant progress in the magnetospheric physics was reached due to coordinated and/or independent efforts of many groups using multipoint measurements with high resolution from the "space fleet" including the INTERBALL satellite quartet. Some of the most important recent findings from the INTERBALL-2 results, from the author's selection, are briefly reviewed. Experimental and modeling problems of the data analysis are discussed, which concern: a) detailed thermal plasma measurements at high altitudes and their comparisons with the concepts of polar wind, SAR-arcs and polarization jet features; b) cusp phenomena as observed from high and medium altitudes; c) small-scale moving electrostatic structures (ions holes, electrostatic shocks, knoidal waves), and their possible role in auroral acceleration; d) pre-breakup quasi-steady arcs and substorm onset observations and models.

Paper Number: ThP.01

A SURVEY OF SPACECRAFT POTENTIAL MEASUREMENTS ON BOARD INTERBALL-2 AND INFERRED PLASMA DENSITIES

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The electric potential of the spacecraft Interball-2 (Auroral Probe) has been analyzed for a period of 18 months starting in October, 1996. Data from the instrument IESP2, as received and filtered on-board the spacecraft by the instrument RON, serve as the main data base. The data have been organized into relevant co-ordinate systems such as MLT and invariant latitude, and grouped according to various geophysical parameters. Using relations between the potential and plasma density which are available in literature and have been derived from spacecraft at higher altitudes (Polar, ISEE) the plasma density at 23000 to 25000 km altitude is inferred. The relative variations of the derived densities indicate a dawn-dusk asymmetry of the location of the cusp region, which would be consistent with results from Polar. Dependencies on magnetospheric activity are presented. The validity of this method to obtain absolute density is discussed. The active control of the spacecraft potential during part of the first three months of data provides another method to test the validity of the assumptions underlying the derivation of the density from the spacecraft-plasma interaction. An outlook on future steps in the analysis of potential data will be given.

Paper Number: ThP.02

**CORRELATED DENSITY AND SATELLITE POTENTIAL MEASUREMENTS
ON INTERBALL AP USING HYPERBOLOID AND IESP
MEASUREMENTS**

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A method has been developed to derive the total plasma density N_e and the satellite potential V_{sat} from the measurements of the Hyperboloid thermal ion experiment on Interball AP. N_e and V_{sat} are estimated by iteratively solving a system of equations describing:

- 1 the theoretical dependence of V_{sat} on N_e (as defined by the condition that the ambient electron current to the spacecraft compensates the photoelectron current from the spacecraft)
- 2 the expected density of each ion species as a function of both V_{sat} and the observed flux distribution. The results obtained are compared with independent measurements by the IESP electric field experiment. It is shown that calculated and measured V_{sat} values are in agreement for densities higher than about 1 or 2 cm^{-3} . Reasons for discrepancies at lower densities are discussed.

Paper Number: ThP.03

MULTI-ION MODEL OF FIELD TUBE: EFFECTS OF ION AND ELECTRON HEATING

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A multi-ion MHD polar wind 1D dynamic model is described which includes in its full form H^+ , He^+ , N^+ , O^+ , N_2^+ , NO^+ , NO_2^+ and O^{++} ions and electrons ("Tube-8"). The model solves coupled equations of continuity, motion and thermal balance along the magnetic field. Results of calculations with the full model, as well as with its earlier reduced versions, are presented for some geophysical scenarios such as "cleft ion fountain", polarization jet event, etc. The calculations show that as a result of short-term electron and/or ion heating, the molecular ions can be strongly accelerated even at ionospheric altitudes, and fast upward ion fluxes appear. Such processes lead to radical modifications in the density-altitude profiles at ionospheric altitudes and important ion upwelling. For these effects the inclusion of molecular ions in the model is critical.

Paper Number: ThP.04

**THERMAL ELECTRON TEMPERATURE DISTRIBUTION
AS MEASURED ONBOARD THE INTERBALL-2 AND MAGION-5 SATELLITES -
FIRST RESULTS**

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The KM-7 and KM-14 instruments onboard satellites of the Auroral Mission allowed to measure the thermal electron temperature in the altitude range of 4000-20000 km and in invariant latitudes of 30-70 deg. Data from the Real Time Telemetry were processed. First results concerning the electron temperature distribution under consideration of various geophysical conditions are shown.

Paper Number: ThP.05

**DEPENDENCE OF THE PLASMAPAUSE POSITION ON GEOMAGNETIC ACTIVITY
ON DATA ALPHA-3 INSTRUMENT/AURORAL PROBE**

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Data on the plasmopause dynamics obtained by means of wide angle ion analyzer Alpha-3 on board Auroral probe during some magnetic storms allow us to arrive at following conclusions:

- on the night, dawn, and day sides the plasmopause begins to move toward the Earth simultaneously and long before the main phase of the geomagnetic storm, maybe just after storm sudden commencement;
- the plasmopause approaches the location nearest to the Earth at the main phase of the geomagnetic storm;
- sometimes plasmopause can move to the Earth up to 2L distance in a short time; reverse motion of the plasmopause starts with the beginning recovery phase of the geomagnetic storm.

Paper Number: ThP.06

**DESCRIPTION AND FIRST RESULTS OF COLD PLASMA MEASUREMENTS
ON BOARD THE MAGION-5 SATELLITE**

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A brief description of KM-14 device for electron temperature and ion RPA measurements is given. One undeployed boom is responsible for a restriction of continuous ion concentration and/or RPA measurements, while the measurement of electron temperature (T_e) is confined in a less degree. The T_e measurements done both onboard the Interball-2 and Magion-5 satellites under similar conditions are compared. The cold plasma measurements are used for explanation of some peculiarities of VLF observations onboard the Magion-5 satellite.

Paper Number: ThP.07

**CASE STUDIES OF STRONG CONVECTION AT NIGHTSIDE
MEASURED ON INTERBALL-2 SATELLITE**

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Cases of very strong medium - scale convection with time of flight ion velocity characteristics in the night sector are described. They occurred in the polar cap near polar boundary of the auroral oval. If the measured ion perpendicular velocity is mapped to ionosphere, the convection velocity will be ~ 3 km/s! The fastest convection of this type was found on January, 10, 1997 when the "magnetic cloud" from Sun disturbed the Earth's magnetosphere. The time of flight features appeared with a quasi - period of about 10 min. The question whether these strong convection cases describe localized or large - scale regions of the polar cap is discussed.

Paper Number: ThP.08

**ENERGY SPECTRA AND PARAMETERS OF COLD ION FLUXES
AS MEASURED BY THE TAIL PROBE ON AUGUST 1995
ALONG THE GEOMAGNETIC SHELLS OF $3.4 < L < 3.8$.**

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The orbit of the TAIL probe at the beginning of the mission provide rare possibility to measure cold plasma spectra along the narrow geomagnetic shells. For instance, the inbound orbit of the Tail probe on October 25, 1995 lay close to $L \sim 3.8$ at geocentric distances $2.6 > R_E > 1.9$. Energy spectra of cold ions recorded by Alpha-3 instrument at $L \sim 3.8$ are very similar and this points on the nearly constant temperature and density of ion fluxes along the shell. Their values are adduced in the report.

Paper Number: ThP.09

**SIMULATION OF HYPERBOLOID MEASUREMENTS AND ION TRAJECTORIES
NEAR THE INTERBALL-2 SATELLITE**

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The response of the HYPERBOLOID energy-mass-angle thermal ion spectrometer onboard the Interball-2 satellite in rarefied magnetospheric plasma is modeled taking into account ion trajectories in the model electric field around the satellite. Algorithms for numerical calculations of the ion fluxes resulting from ion trajectories reaching 16 detecting windows of the instrument are described for different plasma conditions. The modeled ion fluxes and ion distribution functions are compared with the measured ones for several particular cases.

Paper Number: ThP.10

**THE MODEL OF ELECTRIC FIELD DISTRIBUTION
NEAR THE INTERBALL-2 SATELLITE**

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Electric field distribution around a charged satellite in rarefied magnetospheric plasma modifies the particle trajectories reaching the onboard instruments. However, its modeling and thus the calculations of corrections to the onboard measurements of the low-energy plasma, meet with significant computational problems in cases of large Debye length. Two models of calculation of the 3D distribution of the electric potential around the Interball-2 satellite are considered - one for infinite Debye length (vacuum field), another - with its finite value. In the first model the realistic form of S/C with solar panels, booms and antennas is used. Besides, the value of controllable potential of the entrance aperture of the HYPERBOLOID thermal ion mass- spectrometer is taken into account. Numerical algorithms are described together with some results with emphasis on the pattern around the HYPERBOLOID's aperture. For a case of finite Debye length a reduced test model is described where the model of S/C shape is simplified. Numerical algorithms to solve the problem are described together with some preliminary results. Possible effects to the measurements for realistic electric potentials are discussed.

Paper Number: ThP.11

Session IX:

Magnetic Clouds, Storms, Space Weather

**LARGE SCALE CHARACTERISTICS OF INTERPLANETARY DISTURBANCES
OBSERVED IN THE ASCENDING PHASE OF THE SOLAR ACTIVITY**

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A comparative study of three-dimensional propagation properties of transient interplanetary disturbances is performed for two characteristic phases of 11-year solar activity; early ascending phase (November 1997) and the maximum phase (June 1991). These events were apparently associated with solar flares. Principal data source is solar wind speed measurements using the multi-station IPS technique at 327 MHz. Broad interplanetary disturbances with the maximum speed of 800 km/sec were observed in early November 1997, in association with a series of broad flare-associated CMEs observed by SOHO/LASCO coronagraphs. These disturbances propagated both in the northern and the southern hemispheres approximately in a symmetrical manner with respect to the heliospheric current sheet (or the streamer belt). The eruption of the streamer belt is suggested to be the principal sources of the CMEs and their interplanetary consequences. The propagation speed of the disturbance in the region along the heliospheric current sheet were considerably smaller than those in the region apart from the sheet. On the other hand, in the period of the solar maximum, high-speed interplanetary disturbances (about 1000 km/sec at 1 AU), associated with a series of six X10-12 class solar flares in June 1991, showed highly anisotropic characteristics; the enhanced solar wind speeds (>600 km/sec) were predominantly observed in the northern hemisphere of interplanetary space (or to the north of the heliospheric current sheet), in the same hemisphere where the solar flares took place. Close connection between these energetic solar flares and the associated interplanetary disturbances is suggested.

Paper Number: SpW.01

**OBSERVATIONS AND SIMULATION OF HIGH-LATITUDE RECONNECTION
FOR NORTHWARD IMF IN OCTOBER 19, 1995
CME-ASSOCIATED EVENT**

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During October 18-19, 1995 CME-associated event Interball-1 was in dawn sector of the northern tail lobe at about $23 R_E$ behind the Earth and about $20 R_E$ from the aberrated Earth-Sun axis. Many magnetopause crossings were observed during this time interval, and at 17:10 UT on October 19 satellite eventually went to magnetosheath.

Fast 3-D ion spectrometer SCA-1 performed observations from 11:00 UT till 19:00 UT on October 19, when the Earth was immersed in northward-oriented part of CME-associated magnetic cloud. With negative IMF B_y Interball-1 was in favorable position to observe high-latitude reconnection. Satellite remained within reconnection layer within several hours.

We present plasma and magnetic signatures of reconnection including jetting, D-shaped velocity distributions and bipolar magnetic signatures. The filling of the tail with new plasma of relatively high density within tail lobe was also observed.

The global magnetospheric simulation performed for the same time interval shows very complicated magnetospheric dynamics. Simulation indicates that Interball-Tail was on the reconnected field lines most of the time. Plasma entry into the tail lobe from the dusk side and its convection to the dawn side is demonstrated. The shape of the magnetospheric tail changed dramatically during the event.

The overall observations and simulation support strong cusp reconnection characteristic of northward IMF. Talk includes movie made from the results of global simulation.

Paper Number: SpW.02

**IONOSPHERE-MAGNETOSPHERE COUPLING DURING STRONGLY NORTHWARD IMF:
END OF A MAGNETIC CLOUD ON JAN 10-11, 1997**

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After the plasma cloud from a coronal mass ejection had passed the Earth on January 11, 1997, the INTERBALL-2 satellite observed several consecutive dispersion ramps of magnetosheath protons above the evening sector auroral region. The protons were encountered at high magnetic latitudes over a wide local time sector reaching quite close to the midnight sector. We examine the magnetosphere-ionosphere coupling using these injections and a phenomenological model for the solar wind-magnetosphere interaction, which includes 3D models both for the magnetosheath and for the magnetosphere. The model is used to qualitatively identify magnetopause regions that would be open to the magnetosheath, and hence allow the plasma inflow. The plasma entry mechanisms and magnetospheric configuration during strongly northward IMF are discussed.

The ionospheric plasma convection was extremely weak during this period due to the prolonged period of strongly northward IMF; the polar cap potential was only 22 keV and the drift speed about 300-400 m/s. The INTERBALL observations were closely conjugate with measurements from POLAR at much higher altitude (6 R_E geocentric). The POLAR/TIMAS measurements show that the drift speed at that altitude was about 40-50 km/s, consistent with our estimates from INTERBALL. Assuming equipotential field lines, this would lead to ionospheric convection which is a factor of 10 too large. The apparent discrepancy between these measurements is discussed.

Paper Number: SpW.03

MAGNETOSPHERE DISTURBANCES DURING THE PASSAGE OF MAGNETIC CLOUDS: INTERBALL MULTI-SATELLITE OBSERVATIONS

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We describe several results of statistical studies related to the interaction of interplanetary magnetic clouds with the Earth's magnetosphere as observed on the INTERBALL satellites during 1995-1998. Magnetosphere response to the clouds is usually the same as its response to the similar changes of solar wind and IMF parameters and the main cause of very strong magnetospheric disturbances is high pressure pulses on leading and trailing edges of clouds. Interactions of clouds with the magnetosphere results in its compression and deformation, large scale motions of the magnetic tail and initiations of storms and substorms. Several important consequences of these processes are (1) observations of magnetospheric regions and boundaries much closer to the Earth than on average; (2) increases of density and temperature in outer regions of magnetosphere; (3) multiple crossings of geomagnetic tail boundaries presumably due to tail flapping, and (4) bursty fluxes of high energy ions and electrons in the auroral region and polar cap.

Paper Number: SpW.04

HELIO-GEOPHYSICAL SITUATION DURING TWO SUPERSTORMS

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We compared situation on the Sun, in the solar wind, in the Earth magnetosphere and ionosphere during two superstorms: 8-9 February 1986 (minimum Dst = -312 nT) and 13-14 March 1989 (minimum Dst = -600 nT). The equatorward edge of the night side auroral oval according to particle measurements descended to the latitude of 43° for superstorm-86 and to 40° for superstorm-89. The green 557.7-nm emission dominated in the auroras of superstorm-86. The precipitation electron spectrum was comparatively hard (1-30 keV). During superstorm-89, the intensity of the red 630-nm emission exceeded essentially the 557.7-nm emission; the electron spectrum was soft (150-800 eV). An exclusively severe coronal mass ejection (CME) occurred on 10 March 1989. There were no CMEs on 3-7 February 1986. IMF measurements during these storms were practically absent. One can restore the IMF z-component by using the temporal dependence of Dst(t). According to our computations, average BzIMF was -12 nT during the main phase of superstorm-86 and -31 nT during the main phase of superstorm-89 with spikes down to -100 nT. The electric convection potential drop in the magnetosphere seems to reach sometimes 500 kV during superstorm-89.

Paper Number: SpW.05

**OPERATIONAL SOLAR SOFT/HARD X-RAY PHOTOMETER
ONBOARD INTERBALL-TAIL PROBE**

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We present examples of reduced high-time resolution measurements of the Solar X-ray fluxes obtained from the RF-15I photometer. RF-15I has been built by Czech-Polish-Russian consortium. The data obtained are unique as RF-15I is the only instrument observing the Sun at present in the energy range 2-3-5-8-15-30-60-120-240 keV.

We compare our measurements with relevant BATSE and GOES data and discuss their significance for the magnetospheric studies.

Paper Number: SpW.06

**SOLAR ACTIVITY FORECASTING ON 1999-2000 BY MEANS OF
ARTIFICIAL NEURAL NETWORKS**

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Geomagnetic conditions are controlled effectively by solar activity. Three representative parameters characterizing the solar activity are sunspot number (W), 10.7cm radio solar flux (F10.7) and mean solar magnetic field value (SF). These parameters are responsible for different sides of solar activity manifestation and influence on the Earth. Sunspot number is associated with solar flares affecting strongly on Earth's magnetosphere and radiation environment. Earth's ionosphere conditions are tightly related to the F10.7 solar radio flux reflecting solar ultraviolet radiation. Mean solar magnetic field value is related to the interplanetary magnetic field controlling the averaged Earth's magnetosphere conditions. Practically persistent time series of these parameters are appropriate data sets for modeling and forecasting by means of Artificial Neural Networks (ANN). Methods of optimization of ANN input data sets and selection of training, testing and examination sets are discussed in the paper. The dynamical models of the mentioned above parameters are developed by means of ANN. The results and reliability of ANN forecasting for period 1999-2000 are presented and discussed.

Paper Number: SpW.07

**REVIEW OF RF15-I OBSERVATIONS OF SOLAR SOFT/HARD X-RAY EVENTS
CAUSING STRONG MAGNETOSPHERIC DISTURBANCES****S. GBUREK, J. SYLWESTER, M. SIARKOWSKI, Z. KORDYLEWSKI***Space Research Centre, Polish Academy of Sciences***F. FARNIK***Astronomical Institute, Czech Academy of Sciences***O. LIKIN***Space Research Institute of RAS, Moscow, 117810, Russia*

The INTERBALL-Tail Probe RF-15I photometer constructed by Czech-Polish-Russian consortium is the only instrument observing the Sun in the energy range 2-3-5-8-15-30-60-120-240 keV today. We discuss RF15-I high time resolution records for several flares, important in magnetospheric and ionospheric studies. We present in detail selected Sun-Earth Connection Events including April 8-9, 1997 one. For a number of solar flares we perform detailed comparison with BATSE and GOES data. The other events discussed relate to non-solar gamma bursts.

Paper Number: SpW.08

**OPTICAL EMISSIONS AND MAGNETIC FIELD OBSERVATIONS
ABOARD OF INTERBALL -2****K. PALAZOV, S. SPASOV***Solar-Terrestrial Influences Laboratory (STIL) - Stara Zagora Branch
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The UFSIPS instrument on board of INTERBALL -2 measures the emission intensity in vacuum UV- region centered at wavelengths λ 1304, 1356 and 1393Å. In the data output these ionospheric auroral emissions from the footprint of the magnetic field line, crossed by the satellite at a given moment, are represented as a profiles along the satellite trajectory. A very significant question is the attitude aspect problem. A routine procedure is suggested for determination of the angle between UFSIPS optical axis and magnetic field line footprint direction which is used in the data processing. A profile of optical emissions is presented during a substorm on Oct. 19, 1996 at 23 UT. We did try to present for the first time a joint examination of emissions and field -aligned currents (FAC) as seen by the IMAP -3 magnetometer on board of the same spacecraft and to show substorm auroral features related to FAC characteristics.

Paper Number: SpW.09

**COSMIC RAY INTENSITY INCREASES FROM SOLAR FLARES
ON NOVEMBER 4 AND 6, 1997
BY ABOARD INTERBALL-2 AND GROUND BASED MEASUREMENT**

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The events of solar cosmic rays generated during the flares on November 4 (S14, W33;B2) and 6 (S18, W63;B2), 1997 are discussed. On the basis of an analysis of amplitude-phase characteristics of time profiles, obtained by measurement aboard the spacecraft Interball-2 in the energy range of 7-300 MeV, the parameters of the solar cosmic ray propagation in interplanetary space are presented. The event on November 6, 1997 was also observed at neutron monitor stations (Apatity, Moscow, Tixie, Yakutsk). That increase at the Earth's surface taken place on the background of the Forbush-decrease, probably, associated with the preceding flare on November 4, 1997. The above events are the first solar cosmic ray increases in the new solar activity cycle, a complex analysis of which is important in many aspects.

Paper Number: SpW.10

**SOLAR SHORTWAVE IONIZING FLUX IN 1995-1998
FROM THE DATA OF INTERBALL-1 AND ELECTRO SATELLITES**

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The data are presented from integral shortwave ionizing flux measurements during 1995-1998 on board the satellites INTERBALL-1 and ELECTRO. Similar devices SUFR (Solar Ultraviolet Radiometer) were installed on both satellites. The devices are based on the thermo-luminescent method which allows to register the integral energy flux in absolute units at wavelengths shorter than 130 nm and solar Lyman-alpha line (121.7 nm). Information was read from the INTERBALL-1 every day from August 7, 1995 till February 10, 1996, and from geostationary satellite ELECTRO from March 1, 1995 till August, 1998. During 1995-1998 the measured values correspond to a low solar activity (F10=75-80) in absence of large solar flares. During this period the integral flux in the range < 130 nm from the Sun as a star was $7.5-8$ ergs/cm²·s, the Lyman-alpha was about $4.8-6.1$ ergs/cm²·s. From September, 1997, i.e. after the start of Solar Cycle 23, the flux began to increase. The results from the two satellites are in good agreement. They agree also with the Lyman-alpha measurements by the spectrometer SOLSTICE on the UARS satellite till February, 1997.

Paper Number: SpW.11

Session X:

Inflight Operations, Orbits, Informatics

MAGION 5 - STATUS AND MEASUREMENTS SINCE MAY 1998**PAVEL TRISKA***Institute of Atmospheric Physics
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MAGION 5 (68.5 kg) was launched as a part of the INTERBALL 2 Mission on 29 August 1996 with apogee 19196 km, perigee 791 km and inclination of 62.8. A technical failure which occurred immediately after the launch caused a critical deficit of the onboard power and the active work with MAGION 5 had to be stopped one day after the launch. By analyzing the telemetry data and using laboratory simulations the failure was fixed as a short-circuit in the solar array with a theoretical possibility to "disappear" with time. This occurred after 20 months and, on May 6, 1998, MAGION 5 started to work again. After reactivating the scientific payload of MAGION 5 including magnetic field, waves and plasma experiments, the Panska Ves telemetry station started regular data acquisition. A report on status of MAGION 5 and a review of experimental data will be presented.

Paper Number: IO.01

PASSAGE OF SHADOWS BY A TAIL PROBE**I. TZERENIN, M. ARTUHOV, M. RUDAKOVA, S. GAVRILIN***NPO Lavochkina, Khimki, 141400, Moscow region, Russia*

The technical aspects of passage by a tail probe of large shadows . The used methods of preservation of a temperature mode of a space vehicle are described. The ways of minimization of the charge of capacity of a chemical source of an electrical current are described. Forecasting of a condition of the device at passage of the subsequent shadows

Paper Number: IO.02

· FUNCTIONING AURORAL PROBE IN A UNGUIDED MODE**F. BAUM, K. SUKHANOV, I. TZERENIN, S. GAVRILIN***NPO Lavochkina, Khimki, 141400, Moscow region, Russia*

Are resulted given on orientation auroral probe. The condition of onboard systems, their functioning, and sessions of communication with auroral probe is described.

Paper Number: IO.03

**SCIENTIFIC DATA COLLECTION SYSTEM SSNI, EXPLOITATION EXPERIENCE
ABOARD THE INTERBALL 2 MISSION
AND HIGH ENERGETIC PARTICLES INFLUENCE**

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Scientific Data Collection System SSNI was successfully working aboard both INTERBALL missions. Part of orbit time INTERBALL 2 was working inside Van Allen's belts. The SSNI system includes SRAM memory and particles of high energy can randomly change contents of some cells in the memory sometimes even corrupting the data stream collection. Using the possibility to modify the system from the Earth we reprogram SSNI to make the system quite reliable. From January 1997 SSNI is automatically correcting the error in the memory contents and writes the time moment when it was taking place.

About 400 single event upsets (SEU) was registered. Results of the distribution analysis of the SEU and possible reasons are discussed in the paper. Main part of the events is located inside the belts but some amount of SEU may be connected to high magnetic latitude.

Some recommendation to eliminate SEU influence at the future projects are discussed as well.

Paper Number: IO.04

INFLUENCE OF THE HELIO-PHYSICAL FACTORS ON SERVICEABILITY SPACE ENGINE

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The data on functioning onboard systems and their connection with helio-physical factors of space flight (Solar flares, passage large shadows.) are resulted.

Paper Number: IO.05

**OPPORTUNITY OF REALIZATION OF CORRECTION OF PARAMETERS
OF AN ORBIT SPACECRAFT INTERBALL-1**

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Opportunity of use of a working body of system of orientation for realization of correction of parameters of an orbit with the purpose of synchronization of system the satellite - subsatellite, and also for reduction of duration of a presence a spacecraft in a shadow of the Earth in 1999 is under consideration.

The result of a choice of optimum time of realization of a corrections and estimation of the required consumption of a working body are given.

Paper Number: IO.06

ABOUT REVISION OF THE INTERBALL AFTER-FLIGHT ORBITAL SITUATION
ANALYSIS AND THE ORBIT DETERMINATION ACCURACY

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- In the context of the INTERBALL aposteriory orbital situation analysis the problems of the orbit determination accuracy are considered. Analysis of the possible errors sources during orbit determination and the satellite position calculation show the ways, how to provide the adequate calculation of satellite motion and how to improve the preciseness of the orbital data.

- The determined (by KIAM) orbital data (initial data) provide the accuracy 50 km (3 sigma) for the satellite position. But this accuracy can be achieved only at the limited time intervals covered by the used measurements. Out of these time intervals the error grows many times. Each set of the determined orbital parameters (state vectors) is connected with the time $T(i)$ (epoch) and with the time interval of its validity. As a rule this time interval $T(i-1) - T(i)$ is located on the left side of the $T(i)$. It means, that for the adequate satellite motion calculation on the base of the mentioned initial data it is necessary to use the "back" integration. This approach (let call it "interpolation" one) is possible to use only during aposteriory calculations (instead of the "extrapolation" one, used for the satellite motion prediction during long term flight operations planning). The difference between the satellite positions calculated by using different approaches can make up to 500 km.

- Now in the progress is the revision of the aposteriory orbital situation analysis for both INTERBALL satellites. This revision, based on the "interpolation" approach, began at September 1998. The results for 1995, 1996 will be available on late 1998 at the stda.iki.rssi.ru FTP server and at the <http://www.iki.rssi.ru/vprokhor/ssc.htm>. The results of the calculation up to now will be available in the late January 1999.

- There exists also the possibility to achieve more high level of the orbit determination accuracy with error less then 20 km (and better). It can be provided by the planed by KIAM after-flight orbit reconstruction on the base of the full set of the orbital measurements. The first updated orbital parameters (initial orbital data) for both satellites are planed to be ready in the early February 1999, the up to now orbital reconstruction planed to be ready at the early May 1999.

Paper Number: IO.07

ANOD EXPERIMENT FOR LONG-TERM TESTING OF SOLAR PANELS**A.I. KOZLOV***Scientific Engineering Center KVANT, Moscow, Russia***YU.I. GALPERIN, T.M. MULARCHIK***Space Research Institute of RAS, Moscow, 117810, Russia***V.A. GLADYSHEV***Institute of the Earth Physics, Moscow, Russia*

Five experimental small-area solar panels were installed on the INTERBALL-2/Auroral Probe as a technological experiment for long-term tests in orbit. The panels were made using different technologies and had different coatings. Their characteristics were measured inflight during two years to evaluate their performance in real orbital conditions to guide the optimal choices of the solar panels for future space projects. Their degradation in two years of Auroral Probe lifetime caused by interaction of the solar cells with the severe plasma environment along the orbit was measured and analyzed. The average effectivity of the solar panels decreased noticeably during this time. The residual effectivity amounted to about 80% of the initial one for three of them but to 70% and only 20% for the other two, respectively. No surface discharges were noted during all the time of measurements, presumably due to the persistence of the indium oxide conductive coatings throughout this period.

Paper Number: IO.08

FLIGHT DYNAMICS BEHAVIOR OF AURORAL PROBE IN INTERBALL PROJECT**I. BELOVA, N. EISMONT, S. VAINAKOV***Space Research Institute of RAS, Moscow, 117810, Russia*

Auroral Probe spacecraft, launched in framework of INTERBALL project in the fall of 1996 has the same service systems and structure as the Tail Probe launched one year earlier. Both spacecraft (s/c) are spin stabilized with the spin axis periodically targeting the Sun. So the methods of attitude determination and control are supposed to be almost the same. But during maintenance the s/c it is occurred quite significant difference in the flight dynamics behavior between these two s/c. Partially it was expected, for example the role of the gravity gradient torque influence. But also new phenomena have been discovered: unexpected rise of nutation amplitude of s/c. In the article the results of attitude determination are analyzed with the impact on the mentioned phenomena. On the basis of these results some new approaches for the attitude determination and control are proposed. Also the motion of the s/c after consumption of the propellant, followed by increase of nutation amplitude up to 65 degrees, is described. Its mechanical analysis and the methods of attitude motion determination for this case are given. Some preliminary explanations of such s/c behavior are presented.

Paper Number: IO.09

THE INTERBALL GROUND DATA PROCESSING SYSTEM AND PRODUCTS

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- The Interball multisatellite project have been designed to explore the phenomena in the Earth magnetosphere and in the solar wind. This paper describes the ground off-line data processing system at IKI which have been developed to promote efficient data processing, analysis and distribution.
- A short review of general problems in the data processing system is given. This system organizes deconvolution of telemetry stream and using associated ancillary data creates products for distribution to the Interball community and archiving system.
- Briefly descriptions of main functions, characteristics, input and output products and some statistics data are given.

Paper Number: IO.10

STATUS OF THE INTERBALL DATA ARCHIVE AT IKI

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Interball Data Archive contains data produced during Interball mission: raw data, data files produced by express-analysis and preprocessing systems, orbit and attitude data files, key physical parameters, Magion-4 subsatellite data files and other types of data.

Express-analysis data is available for Interball participants within 1 day after telemetry session, level 1 processed data - within 2 weeks. Key physical parameters (KP) are calculated from the level 1 data and are stored in CDF and ASCII formats. Most data for the whole mission duration is available online on large array of magnetic disks and all data is also archived off-line on magnetic tapes.

We provide authorized access to the instrument data and to the key physical parameters. Data files are accessible over local and global networks. Selected data sets could be distributed on CD-R disks and magnetic tapes.

Paper presents main principles of organization of the Interball Data Archive at IKI, its current status and data access statistics.

Paper Number: IO.11

INTERBALL-TAIL KEY PARAMETERS

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We describe the process of the INTERBALL-TAIL Key Parameter preparation, current status of the archive and suggest several future changes.

Paper Number: IO.12



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